MAR 10 1924
Medical Library

VOL. LIII. MARCH, 1924 No. 2.

ARCHIVES
OF
OPHTHALMOLOGY

FOUNDED IN 1869 BY HERMAN KNAPP

EDITED BY

ARNOLD KNAPP AND WARD A. HOLDEN

NEW YORK

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G. P. PUTNAM'S SONS
2 WEST 45TH ST., NEW YORK

PUBLISHED BIMONTHLY SUBSCRIPTION, SIX DOLLARS A YEAR

Entered at the Post-Office, New Rochelle, N. Y., as Second-Class Mail Matter

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ARCHIVES OF OPHTHALMOLOGY.

OBSERVATION ON PHACOANAPHYLACTIC ENDOPHTHALMITIS.[1]

BY ALBERT N. LEMOINE, M.D., AND ALEXANDER E. MACDONALD, M.B. (TOR.)

(FROM THE MASSACHUSETTS CHARITABLE EYE AND EAR INFIRMARY, BOSTON.)

(With three illustrations on Text-Plate VII.)

A REPORT on 168 patients tested intradermally for hypersensitiveness to lens protein, including 14 patients giving positive reactions, eight of which developed intraocular inflammation, and two patients successfully desensitized and operated upon for immature cataract, by the ordinary method.

At the recent International Congress of Ophthalmology held in Washington, Verhoeff and Lemoine (1) showed that about eight per cent of individuals are hypersensitive to lens protein, as demonstrated by the intradermal test for protein hypersensitivity. It was further shown that individuals who are hypersensitive to pig's lens protein are also hypersensitive to the protein of their own lenses, and that where there is a rupture of the lens capsule, traumatic or operative, in such individuals, there results an intraocular inflammation which

[1] Read before the American Ophthalmological Society, Colorado Springs, Colorado June 21, 1923.

Verhoeff and Lemoine have termed Phacoanaphylactic Endophthalmitis.[1]

Further they showed that eyes affected with Phacoanaphylactic Endophthalmitis have a characteristic histo-pathological picture, which apparently they have reproduced in animals sensitized to lens protein.

In a more recent paper the same authors (2) showed that an individual hypersentive to lens protein could be desensitized and successfully operated upon, for immature cataract, by discission and linear extraction.

In the work of Verhoeff and Lemoine, pig, ox, and human lens protein was used, and both dermal and intradermal tests were employed. In the present work pig's lens protein and intradermal tests were used exclusively. The methods of preparing the lens protein and of making the tests were essentially the same as those employed by Verhoeff and Lemoine in their later work and were as follows:

Pig's eyes are obtained as soon as possible, certainly not later than four hours, after the animal is slaughtered. The anterior part of each eye is sterilized by flaming in a Bunsen burner or, better still, by heating a small piece of metal until red hot and singeing the cornea and the surrounding tissues for a distance of about 1*cm* beyond the limbus. A corneal incision, similar to a cataract incision is made, followed by a capsulotomy. The lens is then squeezed out of the eye into a sterile mortar. The latter is wrapped in two layers of sterile cloth and the lenses allowed to dry in a warm place. The process of desiccation requires 24 to 72 hours, depending upon atmospheric condition. One with good laboratory facilities may use an air tight calcium chloride chamber. The lenses are then pulverized to a very fine powder with a sterile pestle. The powder is put up in amounts of 0.03 gram in sterile ampules. These can be made by drawing out $\frac{3}{8}$ inch test tubes. After the weighed quantity of lens powder has been added, the ampule is sealed by heat. When a solution is desired (as a matter of

[1] In a discussion on cataract extraction before the Ophthalmic Section of the American Medical Association, in 1921, Dr. Verhoeff first called attention to the probability that intraocular reaction following cataract extraction was, in some cases, due to hypersensitiveness to lens protein. His remarks on this subject were omitted from the published transactions.

ILLUSTRATING DRS. ALBERT N. LEMOINE AND ALEXANDER E. MACDONALD'S ARTICLE, "OBSERVATION ON PHACOANAPHYLACTIC ENDOPHTHALMITIS."

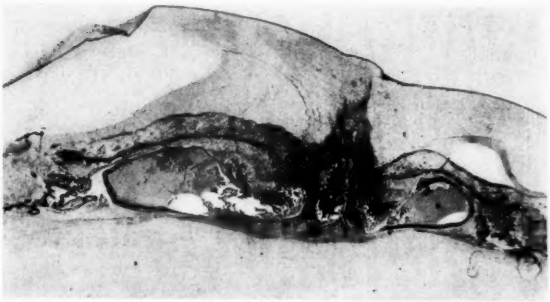

FIG. 1.

FIG. 2.

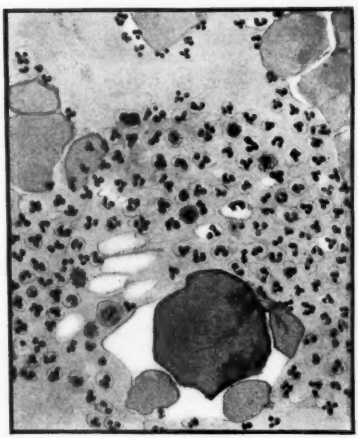

FIG. 3.

fact, only about ½ of the protein goes into solution, the other half remains in the form of a suspension); the top of the tube is broken, and 1*cc* of fresh[1] sterile normal saline solution is added. This makes a 3.3% solution when computed in terms of powdered lens protein or a 10% solution in terms of fresh lens protein.

In making the intradermal test, 0.04*cc* of the above (1:10) solution is injected between the layers of the skin with a Luer tuberculin syringe. For the control, normal saline solution is injected in the same way and amounts at least 8*cm* away from the area chosen for the test. Following are the symbols employed in recording the reactions:

+ + + + = a reaction with an area of erythema over 6 *cm* in diameter, with an area of elevation at point of injection 1 to 2*mm*.

+ + + = a reaction with an area of erythema from 4 to 6 *cm* in diameter, with some elevation at the point of injection.

+ + = a reaction with an area of erythema from 3 to 4*cm* in diameter, and a moderate elevation at the point of injection.

+ = a reaction with area of erythema from 2 to 3*cm* in diameter, with a slight elevation at the point of injection.

± = a reaction with an area of erythema, less than 2*cm* in diameter, with very little elevation at point of injection, but definitely more marked than in the control.

− = when the control and test areas are practically the same.

In a great many cases there is a reaction within ½ hour, which in some cases disappears within an hour. The latter cases are considered negative. Only reactions which persist for at least 24 hours are considered positive. Occasionally the reaction is delayed 12 to 24 hours. These cases are also considered positive.

Before desensitizing a patient, one must first ascertain the degree of hypersensitiveness. This is accomplished by making a differential intradermal test, *i.e.*, by making the tests in three or more dilutions, as follows: 1:10, 1:100, 1:1000, etc.,

[1] The normal saline solution should be fresh, as on standing it becomes slightly acid and irritating to the skin.

solutions of lens protein, computed as of fresh lens. The first desensitizing injection should consist of 0.2*cc* of the solution giving a ± reaction.

The subsequent injections are given at intervals of seven days, which interval is the same as that used by Dr. Walker (3) in his work with various other proteins, the dose being doubled each time until 1*cc* of the full strength solution is injected. At this time the patient should give a negative reaction to the full strength solution and may now be operated upon.

As shown by Verhoeff and Lemoine (2) it is best to continue the injections with the maximum desensitizing dose at weekly intervals after the operation, until the cortical matter is practically all absorbed, as the desensitization is apparently not permament.

The purpose of this paper is to report the results of the intradermal tests with lens protein in 168 unselected cases of injury to the lens, traumatic or operative, with the end results in the operated eyes.

In none of the cases having a negative skin test, 144 in number, was there any subsequent intraocular inflammation, except that in a few cases there was delayed convalescence, due to unavoidable accidents, such as loss of vitreous or loss of the eye due to definite infection. These negative cases, also, include several cases of traumatic cataracts in patients in middle life, whose lenses absorbed entirely without any intraocular inflammatory reaction.

There were ten cases in which there was a ± reaction. Eight of these patients made an uneventful recovery. In one of the remaining two, in which considerable cortical matter was left, there was a marked delay in convalescence, and later secondary glaucoma: in the other case, there was simply a delayed convalescence with an ultimately good end result.

There were 14 cases in which the test to lens protein was positive, the reaction varying from + to + + + + . They are briefly summarized below:

CASE 1.—(Mary M., 38474.) Female. White. Age 50. Admitted to the service of Dr. McDonald, August 12, 1922, with mature cataract O.D. and immature cataract O.S. Physical examination negative.

SUMMARY OF POSITIVE CASES

Case	Age	Diagnosis	Test	Operations	Amount of Cortical Left	Remarks	Vision with Correction
1	50	O. D. Mature Cataract O. S. Immature Cataract	+++	Combined Cataract Extraction Combined Cataract Extraction	Little Large Amount	Funnel Shaped Pupil with Complete Posterior Synechia Desensitized Before Operation. O. S. One Small Synechia, Only	O. D. = 18/18— O. S. = 18/18—
2	35	O. D. Nearly Mature Cataract O. S. Immature Cataract	++++	Combined Cataract Extraction Attempted Intra-Capsular Ruptured Capsule	Fair Amount Large Amount	Long Continued Iridocyclitis, Drawn Pupil Severe Long Continued Intraocular Inflammation. Attempts at Desensitization Failed. Sensitive to Atropine	O. D. = 10/200 O. S. Light Projection Faulty
3	47	O. D. Traumatic Cataract, Drawn Pupil Anophthalmos	++	Combined Cataract Extraction. Later Iridotomy	Small Amount None	Iridocyclitis Following Injury, Also Following Cataract Extraction. No Inflammation Following Iridotomy Eye Lost from Continued Irritation	O. D. 10/200 Nil
4	27	O. D. Normal O. S. Traumatic Cataract	++	Extraction of Intraocular F. B. Linear Cat. Extraction	Large Amount	Intraocular Inflammation, Duration Nine Months	O. S. Light Projection Faulty
5	67	O. D. Mature Cataract	+++	Combined Cataract Extraction	Fair Amount	Intraocular Inflammation Duration Two Months. Drawn Pupil, Complete Posterior Synechia. Sensitive to Atropine	O. D. 10/200
6	60	O. D. Mature Cataract O. S.....	+++	Combined Cataract Extraction	Little	Convalescence Delayed Ten Weeks. Posterior Synechia	O. D. 10/200
7	65	O. D. Sclerosed Lens	+	Combined Cataract Extraction	Practically None	Convalescence Delayed	O. D. F. @ 6 Ft.
8	68	O. S. Nearly Mature Cataract	+	Combined Cataract Extraction	Little	Good Convalescence. Developed Dementia. Sustained Fracture Transferred to M. G. H.	O. S. 10/200
9	Priv. Pt.	O. S. Hypermature Cataract	+	Intracapsular Cat. Ext.	Nil	Uneventful Recovery	O. S. 18/18
10	74	O. S. Mature Cataract	+	Combined Cataract Extraction	Practically None	Uneventful Recovery	O. S. 10/200 Tenth Day
11	72	O. S. Mature Cataract	+	Attempted Intra-Capsular With Ruptured Capsule	Little	Uneventful Recovery	O. S. 18/18
12	50	O. S. Mature Cataract	+	Combined Cataract Extraction	None	Good Convalescence	O. S. 18/18
13	77	O. D. Nearly Mature Cataract	+	Combined Cataract Extraction	Considerable	Convalescence Delayed, Eye Red and Painful, 57 Days later	O. D. 10/200
14	82	O. D. Hypermature Cataract	+	O. D. Combined Cataract Extraction	Practically None	Good Recovery. Fundus Changes	18/60 Discharge V.
15	6	O. D. Perforating Wound O. S. Sympathetic Uveitis	+++	O. D. Iridectomy, Conjunctival Flap, Enucleation O. S. None	Much	Enucleated Eye Showed Characteristic Histo-Pathology of Phacoanaphylactis Endophthalmitis and sympathogenic uveitis	O. D. Nil O. S. 18/18
16	30	O. D. Posterior Cortical Cataract O. S. Posterior Cortical Cataract	++	O. D. Dicission and Linear Extraction O. S. Dicission and Linear Extraction	Considerable Considerable	Patient Desensitized before either Operation. Practically no Irritation from Cortical Matter	O. D. 18/18 O. S. 18/18

August 14th, O.D. combined cataract extraction with peripheral iridectomy. No vitreous lost. Anterior chamber irrigated. Little, if any, cortical matter left.

August 15th, little reaction. Anterior chamber is reformed. Atropine instilled. Double dressing.

August 25th, pupil funnel shaped, anterior chamber deep, pupil does nor dilate with atropine, due to complete posterior synechia to the lens capsule.

August 28th, discission O.D.

September 2d, discharged. O.D. white and quiet. Pupil poorly dilated.

V.O.D. + 11.00⊂ + 3.00 × 180 = $\frac{20}{30}$

V.O.S. F. at 4 feet.

(N.B.—Lens protein test not done on this service in August.)

October 21st, readmitted for extraction of immature cataract O.S., for the meeting of the American College of Surgeons—(Ophthalmic Branch). Lens protein test is + + + . Dr. Verhoeff recommends that the patient be desensitized to lens protein before the operation is attempted.

October 26th, graduating test with lens protein; 10% = + + +; 1% = ++; 0.1% = +. Beginning same date, a full graduated desensitizing course of lens protein was given intramuscularly, alternating right and left deltoid muscles, at weekly intervals.

December 10th, differential intradermal test with lens protein is negative with all dilutions.

December 12th, readmitted for operation.

V.O.S. F. at 3 feet. Iris shadow present. The fundus reflex is seen about the nucleus.

December 13th, O.S. combined cataract extraction with peripheral iridectomy. Van Lint and subconjunctival injections and Verhoeff suture. Anterior chamber was irrigated but a large amount of cortical matter was left. Iris slightly traumitized, owing to tendency of nucleus to protrude through the hole in iris.

December 15th, O.S. rather painful. Pupil not well dilated. Anterior chamber reformed. 1% atropine instilled daily. Double dressing.

December 18th, O.S. pupil not well dilated. 4% atropine instilled.

December 21st, small synechiæ at 4 o'clock. 1*cc* of a 10% solution of lens protein injected intramuscularly.

December 25th, synechiæ has partly separated. Eye whiter and quieter.

December 28th, discharged. O.S. white and quiet. There is a small synechiæ at 4 o'clock, with some cortical matter remaining. Owing to the presence of the cortical matter the

fundus cannot be seen. 1*cc* of a 10% solution of lens protein intramuscularly.

V.O.S. F. at two feet. Not improved.

January 4, 1923, 1*cc* of a 10% solution of lens protein intramuscularly.

January 11th, received 1*cc* of 10% solution of lens protein intramuscularly.

January 22d, V.O.D. + 11.00⌒ + 1.50 × 180 = $\frac{20}{20}$ − 2. V.O.S. + 12.00⌒ + 75 × 30 = $\frac{20}{20}$ − 2. Received 1*cc* of 10% solution of lens protein intramuscularly.

O.U. white and quiet. Tension—normal.

CASE 2.—(Georgianna F., 38995.) Female. Age 35. Admitted to the service of Dr. Ryder, September 8, 1922.

Previous History: March 2, 1921, patient had a combined cataract extraction for a nearly mature cataract O.D., and was discharged 15 days later with a congested eye in which considerable cortical matter remained. The O.P.D. record shows that on April 9th the patient had an iritis, O.D. April 12th, uveitis, O.D. June 14th, an atropine dermitis had developed from 1% solution of atropine *t.i.d.* Eye was still inflamed and painful July 7th, with posterior synechiæ and irregular pupil. September 8, 1921, discission O.D. as a result of which the eye was still inflamed on October 21st.

Physical examination is negative. Lens protein test + + +. V.O.D. with correction was $\frac{15}{200}$: V.O.S. = F. at two feet, not improved.

Local examination. Drawn pupil O.D. Immature cataract O.S. Lateral nystagmus O.U.

September 9, 1922, attempted intracapsular cataract extraction O.S., during which the lens capsule ruptured and the operation was completed by the ordinary method, leaving much cortical matter.

September 15th, patient gradually developing congestion, pain, photophobia and lacrimation O.S. In spite of treatment with atropine, dionin and hot fomentation, the condition is growing worse, and patient is developing descemetitis. Pupil does not dilate. Patient has, also, atropine irritation and hyoscin hydrobromide $\frac{1}{3}$ of 1% is substituted. Paracenthesis performed O.S.

October 16th, no relief following paracenthesis.

October 22d, descemetitis, congestion, pain, and photophobia are all more marked. Dr. Ryder wishes an attempt be made to desensitize the patient to lens protein. The graduated intradermal test with lens protein are positive as follows: 0.1% = +; 1% = + +; 10% = + + + one hour after the tests were made.

October 23d, 24 hours after tests were made, they were

positive as follows: 0.1% = + +; 1% = + + +; 10% = + + + +.

From October 23d to December 20th a full course of desensitizing intramuscular injections of lens protein was given. Twenty-four hours after each injection the patient had an exacerbation of pain, photophobia and lacrimation, followed on the third or fourth day by amelioration of symptoms. At the completion of the course, the graduated intradermal tests were still all positive and further attempts to desensitize the patient were abandoned. Discharged on January 2, 1923. Eye congested, descemetitis marked, and pupil drawn up, cortical matter still present. Patients till has pain, photophobia, and lacrimation. V.O.S. = Light projection faulty.

CASE 3.—(John G., 39549.) Male. Age 47. Admitted to the service of Dr. Derby on October 5, 1922, complaining of loss of vision, O.D.

Past History: Had scarlet fever at age of 12 years. At the age of nine years had an injury to left eye that never caused him any marked trouble, except occasional irritation and pain. O.S. enucleated at the age of 35 on account of recurring irritation and pain.

Present illness: On December 14, 1921, was struck in the right eye by a piece of wood, which immediately destroyed the vision. An iritis developed which lasted six weeks. On March 31, 1922, the patient was referred to Dr. Derby for extraction of the resulting traumatic cataract. An iritis followed the extraction which lasted three weeks.

Local examination: O.D. Lids and lacrimal apparatus apparently normal. Cornea has a scar at 5:30 o'clock, extending from *2mm* from limbus towards the center for a distance of *2½mm*. There is an operative scar in the limbus above. The anterior chamber is shallow and the iris is incarcerated in the traumatic corneal scar. The pupil is drawn up and occluded by a membrane extending to the limbus above and filling the coloboma which is slit-like. No fundus reflex seen. Physical examination negative. Vision O.D. Light projection good. V.O.S. anophthalmos. Lens protein test = + +.

October 6th, iridotomy and separation of anterior synechiæ O.D., by Dr. Derby. Dressed with double bandage and atropine ointment.

October 9th, little reaction. Good anterior chamber. Atropine instilled daily.

October 12th, eye quieting nicely.

October 16th, discharged to home Doctor. Eye white and quiet. Good anterior chamber. Has vitreous opacities,

apparently from old hemorrhage. Vision on discharge + 12.00-$\frac{20}{200}$. Patient not seen since discharge.

CASE 4.—(Charles K., 38113.) Male. White. Age 27. Admitted to the service of Dr. Thompson, July 24, 1922, with traumatic cataract O.S. V.O.S. Light projection good. Physical examination negative. Lens protein test; 10% solution = + +; 1% solution = +.

History: Had steel intraocular foreign body May 2, 1922. The steel was removed via anterior route, May 3d, with the giant and small magnets. Discharged June 9th, with congested eye and poorly dilated pupil. The lens became cataractous and the eye developed signs of intraocular inflammation, and gradually became more painful.

Local examination showed conjunctival and deep circumcorneal congestion. Good anterior chamber. Iris was muddy, discolored and bound down to the lens by four large synechiæ. Tension normal.

July 25th, O.S. linear cataract extraction with separation of the synechiæ. Considerable cortical matter remains.

Following operations the eye remained painful and congested in which condition he was discharged to O.P.D. on August 5th, with good light projection. The patient reported regularly at the O.P.D. until December 19th, when owing to the fact that O.S. was still congested, light projection faulty, tension minus, and still very painful, Dr. Ryder advised enucleation. The patient returned to the clinic in February, 1923, the eye was congested and soft, and the light projection still faulty. An intradermal test with uveal pigment was negative and enucleation was postponed.

CASE 5.—(Margaret C., 37856.) Female. White. Age 67. Admitted to the service of Dr. Thompson, July 11th, with nearly mature cataract O.D. and immature cataract O.S.

V.O.D. shadows. Light projection good. V.O.S. with correction $\frac{20}{100}$. The lens protein test + + +.

Physical examination negative, except that the teeth are in bad condition.

July 12th. Combined cataract extraction, O.D.

July 18th, pupil small, considerable cortical matter remains.

July 20th, O.D. begins to be painful. The pupil is not well dilated. Conjuctiva congested.

July 25th, patient is sensitive to 1% atropine and hyoscin hydrobromide $\frac{1}{3}$ of 1% substituted. Eye very painful. Cortical matter is absorbing slowly.

August 8th, eye quieting slowly. Eye still irritable and painful in spite of hyoscin, dionin and hot fomentations.

September 1st, eye has quieted very slowly. Is now nearly white. The pupil is drawn up and there are posterior synechiæ of iris with remnants of critical matter and capsule that partly occludes pupillary opening.

V.O.D. with correction = $\frac{20}{100}$. T. = normal.

CASE 6.—(Annie W., 37224.) Female. White. Age 60. Admitted to the service of Dr. Lancaster, June 7, 1922, with nearly mature cataract, O.D. V.O.D., F. at 1 foot.

Physical examination, negative. Lens protein test + + +.

June 8th, combined cataract extraction O.D. Very little cortical matter left.

June 15th, good anterior chamber. Pupil well dilated. Very little cortical matter present. There is a posterior synechiæ of the iris at four o'clock.

June 24th, patient discharged. O.D. congested. V.O.D. = F. at 1 foot, not improved.

June 26th, (O.P.D.) O.D. still congested with slight increase in tention.

August 30th, vision with glasses $\frac{20}{200}$.

CASE 7.—(Mary N., 38500.) Female. White. Age 65. Admitted to the service of Dr. Derby, August 14, 1922, with sclerosed lens O.D. Blocked pupil O.S. from former prolapse of iris, after cataract operation. Lens protein test = +. The patient was a diabetic but is now sugar free, and blood sugar within normal range. Heart and lung physiological.

August 22d, combined cataract extraction O.D. Practically no cortical matter left.

August 26th, some striped keratitis.

September 2d, Discharged with pupil well dilated. Some capsule in the pupillary opening. Moderate congestion. V.O.D. with correction = F. at 6 feet.

CASE 8.—(James S., 39203.) Male. White. Age 68. Admitted to the service of Dr. Derby, September 18, 1922, with immature cataract O.D. and nearly mature cataract O.S. Lens protein test = +.

V.O.D., − 1.00 = $\frac{20}{100}$.

V.O.S., = F. at 1 foot. Light projection good.

Physical examination at the Massachusetts General Hospital showed arteriosclerosis, cardiosclerosis, and chronic nephritis.

September 19th, combined cataract extraction O.S. Little cortical matter left.

September 21st, patient developed acute dementia and sustained a severe fall that resulted in a fracture of left humerus.

September 27th, transferred for surgical treatment to the Massachusetts General Hospital. No cortical matter in pupillary opening. Eye in good condition. Tension normal. V.O.S. with approximate corrections = $\frac{20}{200}$+.

CASE 9.—(Herbert M., 39683.) Male. Admitted October 13, 1922, as a private case (Dr. Verhoeff). Hypermature cataract O.S. Physical examination negative. Lens protein test = +. He was operated October 14th, intracapsular extraction without iridectomy. No loss of vitreous. He made an uneventful recovery.

October 30th, V. with correction = $\frac{20}{15}$.

CASE 10.—(Jeanette H., 39854.) Female. White. Age 74. Admitted to the service of Dr. McDonald, October 25, 1922, with mature cataract O.S. and incipient cataract O.D. Lens protein test was +. Physical examination showed chronic cardio-vascular disease (mitral stenosis, aortic insufficiency and arteriosclerosis) and chronic right otitis media. On October 25th, a combined cataract extraction O.S. was performed with peripheral iridectomy. Practically no cortical matter remained. She was discharged in 10 days, after an uneventful recovery, with vision of $\frac{20}{100}$. There was a small amount of lens capsule in the pupillary opening.

CASE 11.—(Peter M., 39874.) Male. White. Age 72. Admitted to the service of Dr. Verhoeff October 23, 1922, with mature cataract O.S. Physical examination negative. Lens protein test +. Was operated October 26th, by the intracapsular method. The lens capsule ruptured as the lens was being delivered, but practically no cortical matter was left. He was discharged in 10 days after an uneventful recovery (except a striped keratitis). Vision $\frac{20}{30}$. Eye white and quiet. Pupil well dilated.

CASE 12.—(Sarah V., 39244.) Female. White. Age 50. Admitted on September 21, 1922, to the service of Dr. Thompson, with a mature cataract O.S. Aphakia O.D., following intracapsular extraction. Physical examination negative. Lens protein test = +. September 22d, combined cataract extraction O.S. without complications. No cortical matter left. Anterior chamber not irrigated. The

patient was discharged in 11 days with eye slightly congested. The pillar of the iris bound down to corneal wound on the nasal side.

V.O.D. with correction = $\frac{20}{200}$.
V.O.S. with correction = $\frac{20}{30}$.

CASE 13.—(John O., 39455.) Male. White. Age 77. Admitted to the service of Dr. Derby, September 2, 1922, with nearly mature cataract O.D. Lens protein test = +.

September 3d, combined cataract extraction O.D. with Van Lint injection of orbicular occuli. Considerable cortical matter was left, which appeared to be absorbing well, although the pupil did not dilate. The patient was discharged in 10 days with eye slightly congested with some cortical matter remaining.

V.O.D. with correction $\frac{20}{200}$.

Twelve days later in O.P.D. eye was congested.

Fifty-seven days later in O.P.D. O.D. was still painful and congested.

CASE 14.—(Calvin R., 39459.) Male. White. Age 82. Admitted to the service of Dr. Derby on October 2, 1922, with early hypermature cataract O.D. Immature cataract O.S. Examination negative except for aneurism of aorta. Lens protein intradermal test = +. Was operated O.D., October 3d, by the combined method leaving practically no cortical matter. Was discharged in 11 days with O.D. white and quiet. There was capsule in pupillary opening and at discharge the V.O.D. = $\frac{8}{200}$. Not improved.

In addition to the foregoing cases there were two other cases with positive test to lens protein, which are not included above, since one (Case 15) was, in a sense selected, the diagnosis having been made by Dr. Verhoeff on the microscopic examination, and subsequently confirmed by the intradermal tests and in the other (Case 16) the test was done after the above series was completed.

CASE 15.—(Arthur M., 38900.) Italian. Age 6. Admitted to the Massachusetts Charitable Eye and Ear Infirmary, on the service of Dr. McDonald, on July 23, 1922. Past and family history, negative. One and one half hours before admission, while reaching to a shelf for an open knife, it fell and struck him in the right eye, inflicting a perforating wound to the eyeball.

Examination on admission: O.D. The lids and con-

junctiva were normal. The cornea was clear, except for a perforating wound extending from the limbus at 12 o'clock to the limbus at 6 o'clock. There was no anterior chamber and a large portion of the iris with lens matter and vitreous protruded through the upper part of the wound. Under ether narcosis all the prolapsed iris, vitreous, and lens were excised, and the edges of the iris were replaced. The apposition of the wound was good, so no conjunctival flap was made. Instilled 1% solution of atropine sulphate and bichloride ointment and applied a double bandage.

July 26th, O.D. lens much swollen which causes the corneal wound to gap with small prolapse of iris at top. The prolapsed iris was excised and the upper part of the cornea, where the wound was gaping, was covered with a conjunctival flap dissected from above.

July 29th, the conjunctival flap is in position. The anterior chamber has not reformed. Pupil irregular. The eye is treated twice daily with boracic acid solution, ½% solution of atropine sulphate, and bichloride of mercury ointment.

August 8th, the eye is fairly white and quiet. The flap is in position over upper part of the wound. Anterior chamber reformed but shallow. Pupil not well dilated.

August 14th, O.D. condition about the same, but pupil not so well dilated. O.S. Shows no signs of involvement.

September 2d, O.D. Same as above. O.S. There is congestion of the conjunctiva, also, deep circumcorneal congestion. The pupil reacts more sluggishly to light than before. No definite descemetitis. Enucleation of O.D. refused by parents, so patient was discharged against advice.

September 6th, readmitted to the wards. Condition of right eye same, except is painful. Enucleation of O.D. advised. Under ether narcosis enucleated O.D. Left eye shows definite signs of photophobia and is tender to palpation. Ciliary conjection marked. Descemetitis lower portion of cornea. Pupil dilated. Several posterior synechiæ. Fundus not clearly seen. Atropine sulphate ½% *t.i.d.*

September 8th, O.S. There is a fair amount of conjunctival and ciliary congestion with more, but not marked, photophobia. Eye is sensitive to pressure. Increased deposits on Descemet's membrane. Pupil fairly well dilated. Fundus obscure and disk hazy. Vision = F. at three feet. Weight 38½ pounds. Sodium salicylate gr. x. *t.i.d.* Blood count W.B.C. 8,000. Polys. 44%, lymphocytes 52%, large mononuclears 4%.

September 20th, intradermal test = + + +.

September 28th, O.S. much better. Eye white and quiet. Vision with correction $\frac{1}{10}$.

September 30th, O. S. Very much better. Details of fundus made out for first time. Still many dust-like opacities in the vitreous.

October 8th, O.S. White and quiet. Discharged to O.P.D. with atropine sulphate ¼% *t.i.d.* Sodium salicylate gr. x. *t.i.d.*

February 4, 1923, complement fixation with uveal pigment antigen, by Dr. Alan Woods (4), was negative.

February 14th, the intradermal test with $\frac{1}{10}$% solution of uveal pigment was immediately positive, but negative after 24 and 48 hours. At this time the sympathetic uveitis was not very active.

Pathological report O.D. No. 4602. Fixation in 10% formalin.

There is a healed perforating wound, extending entirely across the center of the cornea. The corneal epithelium is everywhere intact. The stroma is œdematous, and the cornea is thickened, 4*mm*. The corneal corpuscles are somewhat increased. There is a cellular infiltration at the periphery of the cornea, extending 3*mm* anterior to the canal of Schlemm, consisting of lymphocytes, eosinophiles, and a few polymorphonuclear leucocytes. A round cell infiltration also occurs for 2*mm* on either side of the corneal wound and here the thickness of the cornea is increased to 2*mm*. Descemet's membrane with its endothelial lining is everywhere intact, except at the site of the wound. The posterior edges of the corneal wound are separated 1.5*mm*, and the gap is filled with a mass of granulation tissue that extends backward through the lens and projects slightly into the vitreous. The central part of the mass is markedly infiltrated with pus cells and eosinophiles surrounding numerous globules of lens matter, and shows here and there areas of epithelioid cells and a few giant cells. The pupillary margins of the iris are adherent to the edges of the wound and the mass of tissue extending from it.

The base of the iris is adherent to the ligamentum pectinatum by organizing tissue. The whole iris is markedly congested and infiltrated throughout, with mononuclears, pus cells, and eosinophiles, and shows here and there denser nodules consisting chiefly of mononuclears.

The anterior chamber on either side of the mass described above, is filled with serum containing many eosinophiles, a few pus cells and mononuclears. These cells are most numerous on the surface of the iris, from the stroma of which they are apparently derived.

There is a cyclitic membrane that completely surrounds the lens and is continuous with the mass of granulation tissue passing through the center of the lens. Anteriorly the

iris is firmly united to this membrane. On each side of the mass of granulation tissue a considerable amount of lens matter remains enclosed in the lens capsule. This is largely liquefied but contains, here and there, areas of hyaline globules, which are markedly surrounded with polymorphonuclear leucocytes among which are many eosinophiles.

There is a rim of normal lens substance about the periphery. From the mass of granulation tissue in the center of the lense, numerous fibroblasto and endothelial cells are extending into the lens matter.

The ciliary body is markedly congested and swollen and its surface is covered, as far back as the ora serrata, with a dense cyclitic membrane. From the surface of the membrane there is a marked exudation of endothelial cells into the vitreous.

The posterior part of the ciliary body and the anterior part of the choroid shows a marked perivascular infiltration with small round cells. The choroid is congested throughout, and in the fundus shows a moderate number of small foci of perivascular infiltration. These foci consist of lymphocytes and epithelioid cells, such as are seen in sympathogenic uveitis. The retina is in situ, except for a microscopic separation at the disk margin. The retina is infiltrated with endothelial cells, some of which form large nodules on the surface of the retina. A few of these nodules are found free in the vitreous. The ganglion cells are well preserved in the area of the macula, but much reduced in the periphery. The nerve fiber layer especially towards the periphery shows extensive gliosis. In the anterior part of the retina there is marked perivascular lymphocytic infiltration.

The optic disk is markedly swollen *2mm* and congested throughout, and shows a slight round cell infiltration. The surface shows some glial proliferation.

Setions stained by the Verhoeff modified gram stain shows no intraocular micro-organisms.

Case 16.—(John L., 41471.) Male. Italian. Age 29. Admitted to the service of Dr. McDonald on February 5, 1923, with Posterior Cortical Cataracts, O.U.

V.O.D. Shadows L.P. good.

V.O.S. with correction $\frac{2}{10}$—1.

History: Patient was first seen in O.P.D. on October 21, 1922. At that time he complained that his vision was too poor to enable him to do his special work in a rubber factory. The Massachusetts General Hospital report showed physical examination negative. Blood Wassermann, negative. There was one root abscess that was treated.

November 19th, the test with lens protein was positive +

in 20 minutes and + + in 24 hours. Beginning on November 25, 1922, a full desensitizing course of intramuscular injections of lens protein was commenced and completed February 5, 1923, at which time the graduated tests were negative in all dilutions.

February 6th, discission O.D.

February 8th, discharged to O.P.D., little reaction O.D. Pupil well dilated, eye white and quiet, tension normal, to return half-weekly for observation.

February 8th to March 15th, the patient received weekly injections of 1*cc* of 10% solution of lens protein. The lens became quite opaque. There was considerable cortical in the anterior chamber, and the pupil remained well dilated with 1% atropine *t.i.d.* Following the weekly injections the eye was painful and slightly congested for 24 hours, but at no time was there severe discomfort.

March 16th, O.D. Linear extraction with peripheral iridectomy using Van Lint and subconjunctival injections. The iris was somewhat traumatized with the capsule forceps. The anterior chamber was irrigated but considerable cortical was left on the temporal side. Atropine was instilled and a double bandage applied.

March 18th, O.D. Moderate reaction, pupil fairly well dilated, considerable cortical remains.

March 24th, V.O.D. with correction $\frac{1}{60}$ plus 2.

March 25th, discission O.S.

March 27th, Lens O.S. rapidly becoming cataractous. Tn = Normal. Moderate reaction.

March 31st, O. S. Linear cataract extraction as for O.D. During the operation vitreous appeared and a very small amount was lost; atropine instilled, double dressing. A large amount of lens matter was left in the eye.

April 5th, O.S. Moderate reaction, pupil fairly well dilated. Discharged to O. P. D. to return for regular weekly lens protein injection. Tension normal. No pain or discomfort. Instilled 1% atropine *t.i.d.* O.U.

May 15th, the left eye has shown practically no reaction in spite of the large amount of lens matter present. This has absorbed very slowly and still occludes three fourths of the pupil. With correction the vision = $\frac{1}{60}$ + in each eye.

CONCLUSION.

In a series of 168 unselected cases tested for lens protein hypersensitiveness, fourteen gave positive reactions of varying degree. Seven patients; Cases 1, 2, 3, 4, 5, 6, and 13, in which there remained a fair amount of free cortical matter

developed intraocular inflammation. This inflammation varied with the amount of cortical matter left and, also, according to the degree of hypersensitiveness of the patient as demonstrated by the skin test. None of the cases giving a negative test to lens protein developed an intraocular inflammation, except those with active infections.

The microscopic findings in the eye affected with phacoanaphylactic endophthalmitis, which was enucleated, were identical with those reported by Verhoeff and Lemoine, except that there was in addition an early sympathogenic uveitis. This complication was merely coincident, as six other patients who had recently had a sympathetic uveitis gave negative tests to lens protein.

Two patients markedly hypersensitive to lens protein were successfully desensitized, as demonstrated by negative intradermal tests, and successfully operated upon for immature cataract, by the ordinary method.

In one case the patient, already affected with phacoanaphylactic endophthalmitis, attempts at desensitization by our present technique, to ameliorate the condition, were unsuccessful. This case illustrates the danger of attempting an intracapsular operation on a patient who is under fifty years of age.

Therefore, patients with immature cataracts who are under fifty years of age and hypersensitive to lens protein, should be desensitized or, failing in this, the operation should be postponed until the cataract is mature.

After the desensitization of hypersensitive patient under fifty years of age, the operation of discission followed by subsequent linear extraction apparently gives the best results.

The skin test for lens protein hypersensitiveness is apparently necessary only in the following types of patients:

1. Those with immature cataracts.
2. Those with traumatic cataracts. If the test is positive every effort should be made to remove the lens matter by operation as early as possible.
3. Those failing to develop good vision following a previous operation on the other eye, and particularly those who give a history of long continued pain and redness following a previous operation for cataract extraction.

We wish to avail ourselves of this opportunity to thank the following Surgeons of the Massachusetts Charitable Eye and Ear Infirmary, for permitting us to carry on this work on their services, and allowing us to publish our results: Drs. Verhoeff, Derby, Thompson, Lancaster, Ryder and McDonald. Also, Dr. Alan C. Woods for uveal pigment for test and for the serum examination made in Case 15.

We are especially indebted to Dr. Verhoeff for the many suggestions and corrections, and for the micro-photographs and the pathological specimens.

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THE CONVERGENCE NEAR POINT, ITS ACCURATE DETERMINATION AND PRACTICAL IMPORTANCE

By Dr. ALEXANDER DUANE, New York.

(With one figure in the text.)

THE determination of the convergence near point forms one of the most important steps in an examination of the motility of the eye—one that should never be omitted in a routine test of the refraction and motility. For this is the main and often the only means by which we can determine whether a convergence insufficiency is present or not, and thus decide as to the ætiology and the clinical significance of the deviation shown by the other tests. It is important, therefore, that this determination should be made precisely and in a standardized way, so that the results of examination by different observers shall be strictly comparable. It is also important to have some simple means of deducing from the position of the convergence near point, as we measure it, the actual amount in degrees by which each eye is converging.

In an article on the convergence index presented before the American Ophthalmological Society in 1914,[1] the author indicated a method by which both of these objects could be effected. The introduction of a new term, such as convergence index, may have complicated the matter a little. Moreover, the article involved certain assumptions which, while not essentially impairing the accuracy of the method, need modification. Accordingly, the following statement is presented with the intent of removing all inaccuracies and reducing the investigation to its simplest form.

[1] *Archives of Ophthalmology*, 1914, p. 476.

We must start first with a conception of what happens when the eyes converge. Each rotates about a center of motion which Donders located at a point about 13.5*mm* back of the corneal apex. According to recent investigations by George and others[1] for rotations of the eye 20° temporally and 30° nasally, the center of motion is a fixed point situated 15.4*mm* behind the corneal apex and 1.65*mm* to the nasal side of the visual axis. It is thus 8.4*mm* behind the nodal point of the eye and 7.4*mm* in front of the macula.

For excursions of the eye beyond 20° temporally or 30° nasally, the center of rotation no longer remains fixed, and the analysis of the movements consequently becomes complicated. We shall not, however, concern ourselves with rotations beyond this amount, as in testing the convergence we rarely have to do with adduction movements of over 30°.

Assuming, therefore, that the center of rotation remains fixed, and that the relations are as indicated by George,[2] the following figure illustrates what happens.

Let M be the macula and N the nodal point of the right eye when in the primary position. MNH then represents the visual axis when the eye is looking straight ahead. A, the center of rotation of the eye, lies at a distance $AO = 1.65mm$ to the nasal side of MN. B is the center of rotation of the left eye, LU the visual axis of the left eye, when looking straight ahead. ACB is the base line connecting the centers of rotation of the two eyes, C being its mid-point. CP is the median line of the head.

When, now, the right eye is rotated in so as to be directed at a point P of CP, the nodal point N swings inward to N', and the macula M outward to M', about A as a center, and the visual axis assumes the position $M'N'$ intersecting its original position MN in the point V. M', N' and P are in a straight line. The angle of rotation which represents the adduction angle of the eye is NAN'.

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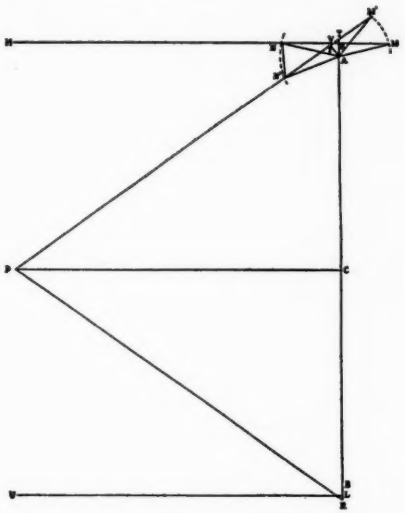
[1] *American Journal of Ophthalmology*, October, 1923.

[2] It makes no difference in the essential accuracy of what follows whether these relations are precisely as indicated or not. Whatever they are, the relation between the position of the convergence near point and amount of convergence adduction remains the same.

Draw AI perpendicular to $M'N'$, and prolong AO so as to intersect $M'M'$ in T. Then in the triangles MNA and



RELATION BETWEEN CONVERGENCE NEAR POINT AND CONVERGENCE ANGLE

A, center of motion of right eye; *B*, center of motion of left. C, midpoint of intercentral line. P, point on which eyes converge. M, macula, and N, nodal point of right eye when latter is looking straight ahead; *MONH*, visual line when eye is thus directed. M', macula, *N'*, nodal point, and *M'TN'P* visual line when eye is converged to *P*. *U*, visual line of left eye when looking straight ahead; *RP*, visual line when converging on *P*. $NAN' = MAM'$, angle of rotation (convergence adduction). As shown in text, this equals angle *TPC*. The converging lines of the two eyes (*TP* and *RP*) do not start, as is usually assumed, from the centers of motion of the two eyes (*A* and *B*), but from a point from 1.7 to 2.0*mm* or more further out (*T* and *R*). Practically, however, for all ordinary cases they may be regarded as starting from *O* and *L*, respectively. It is thus seen that the interaxial distance, *OL*, and not the intercentral distance, *AB*, is the important thing to measure in determining the convergence angle.

$M'N'A$ the sides are respectively equal ($MN = M'N'$, $AM = AM'$, $AN = AN'$). Hence the triangles are equal, and the angle $ANM = AN'M'$.

Again, in the triangle VNN' the angle $VNN' = ANN' + ANM$ and the angle $VN'N = AN'N - AN'M' = AN'N - ANM$. Hence $VNN' + VN'N = ANN' + AN'N$. Accordingly, angle $NAN' = 180° - (ANN' + AN'N) = 180° - (VNN' + VN'N)$ = angle $NVN' = TPC$.

In other words, the angle through which the eye rotates about the eccentric point A in order to converge on P is equal to the angle TPC, which thus represents the true *convergence adduction* of the eye, which we may denote by a. The tangent of this angle is represented by $\frac{TC}{PC}$. T is so close to O (even in extreme degree of convergence being less than 0.5*mm* from it) that without sensible error[1] we may say that $\tan a = \frac{CO}{PC}$. But CO is one half the distance between the visual axes of the two eyes (interaxial distance) and PC is the distance of the convergence near point P from the base line AB connecting the centers of rotation of the two eyes (convergence distance).

For all values of a practically met with, the following simple relation[2] holds good:

$$a + \frac{2CO \times 25}{PC} + 1.5°$$

or *the angle by which an eye converges on an object is found by multiplying the interaxial distance by 25, dividing it by the convergence distance, and adding 1.5°*. If, for example, the interaxial distance is 60*mm*, and the convergence distance 75*mm*, the angle through which the eye is converging is

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[1] To those who wish to be needlessly precise in such matters the following may be offered: The triangles AN'I and ANO, having one side and two angles equal, are equal; hence $AI = AO$, so that $AT = AO$ sec. $IAT = AO$ sec. a, and $OT = AO$(sec. a—1). Hence, having found an approximate value of a from the formula $\tan a = \frac{CO}{PC}$, either trigonometrically or by the simple method given below, it is easy, using this approximate value of a, to compute OT and hence CT. This, then, gives the precise value of a from the formula $\tan a = \frac{CT}{CP}$.

As a matter of fact, the error introduced by using the approximate value $\tan a = \frac{CO}{PC}$ tends to rectify itself, for as a increases and this error with it, the 1.5° that we empirically add in order to get a is itself too large and should be diminished to produce exact results.

[2] Deduced empirically from the fact that for tangents of angles between 1° and 30° the relation holds that $\tan a = \frac{2 \times a - 3°}{100}$, whence $a = \tan a \times 50 \times 1.5° = \frac{25 \times 2CO}{PC} + 1.5°$.

$$\frac{60 \times 25}{75} + 1.5° = 21.5°.$$

This will hold for all values of *a* from 11° to 30° or, with eyes of average interaxial distance for all convergence distances from 130 to 55*mm*. For distances less than this (55 − 50*mm*)[1] 1° should be added to the fraction instead of 1.5°. If the distance is greater than 130, the following additions should be made:

Distance of object 130–300*mm*.....add 1°
" " " 400–600*mm*.....add 0.5°
More remote point.....add .0°

Thus, if the eyes, having an interaxillary distance of 55 are converged on an object at 150*mm*, the adduction of each would be

$$\frac{55 \times 25}{150} + 1° = 10°$$

If directed at an object 2 meters distant. they would each be converging

$$\frac{55 \times 25}{2000} + 0° = 0.7°$$

One fact deduced from the above demonstration deserves to be especially emphasized, because it runs counter to the statements and particularly to the illustrations contained in some text-books. When the two eyes converge on a point such as *P*, so that their visual axes meet in the latter, these axes do not, as is often represented, pass through the centers of the rotation of the eyes (*A* and *B*). On the contrary, they intersect the intercentral base-line in points (*T* and *R*) 1.6*mm* and more to the temporal side of the centers. Moreover, the angle by which the eyes converge is not, as is also usually represented, that between the lines drawn from *P* to the two centers of rotation *A* and *B*, but between the lines drawn from *P* to the two points *T* and *R*, or practically to the two points *O* and L. That is, *it is the interaxial and not the intercentral*

[1] But when *a* exceeds 30° all calculations become rather uncertain on account of the probability of error in the measurement and also because of the probable shifting that now takes place in the center of rotation.

distance that we have to consider in making our measurements and determining the convergence angle.

It remains to indicate how the two factors in this determination, *viz.*, the interaxial distance and the convergence distance, are ascertained.

To ***determine the interaxial distance***, which is not the same as the interpupillary distance, the observer proceeds as follows: Placing the patient in a dark or half-dark room, he flashes the light from an ophthalmoscopic mirror on the patient's right eye, and directs him to look at the mirror with his left eye covered. The observer at the same time looking through the mirror, notes the exact position of the corneal reflex and measures its distance from the corneal margin. He thus determines the position of the visual point in that eye. He then does the same for the left eye. The visual points being thus determined, patient and observer face each other, the patient covering his left eye, the observer his right, and each with his uncovered eye looking straight into the uncovered eye opposite him. The observer places the zero mark of a millimeter scale in line between his open eye and the visual point of the patient's eye. Then each shuts the eye that was open and opens the one that was shut, the patient at the same time being directed with his now uncovered left eye to look into the observer's right. The point in the scale in line with the patient's left visual point will indicate the interaxial distance. To check the result, the patient should again close his left eye and the observer his right, each then opening the eye that was closed. The zero point of the scale in this case should still be opposite the patient's right visual point.

It is important to make this measurement, not only in determining the convergence near point but also in securing proper centration of glasses, for in distant vision the optical centers of the glasses should be separated by an amount equal to the interaxial (not the interpupillary) distance.

The ***base-line convergence distance*** (PcB, *i.e.*, the distance of the convergence near point, Pc, from the base-line) is precisely measured as follows: The patient's correcting glasses, or in lieu of these a trial frame or spectacle frame placed on the patient's nose, are used as a reference plane, which is adjusted so as to be just 9.5*mm* in front of the corneal apex when

the eyes are directed straight ahead. The apex of a millimeter rule is placed against the point where the reference place crosses the nose, and the rule itself is held perpendicular to the plane, so as to lie strictly in the mid-line. Along this the test-object, which may consist of a pin with white head *2mm* in diameter, or a minute dot on a card, is carried straight toward the patient's nose, the patient all the time being exhorted to converge on it as sharply as he can. The moment the object doubles insuperably, or the moment one of the patient's eyes is seen to diverge, the distance of the object from the reference plane is measured. This distance plus *25mm* will equal the distance (PcB) of the convergence near point from the inter-central base-line.

When the patient has considerable vertical deviation, his converging power tested in this way may appear to be poor when really it is quite good. For when the test-object is brought toward the eyes, he sees two images which he cannot bring together because they are on different levels. As he cannot unite them he makes no attempt to converge. In that case the dot used as the test-object should be replaced by a vertical line. The patient will converge on this, because when he does so the two images will unite, even if on different levels, since the bottom of one will join with the top of the other. On such an object a patient will be able to converge sharply, even when for the dot he had, apparently, very little converging power.

In measuring the convergence in this way the patient should be provided with his reading correction, properly centered, *i.e.*, decentered 4–5*mm* in. When the reading glasses are strong, it is well to compare the results with and without glasses, for the latter, even if decentered, produce a very sensible prismatic effect, thereby vitiating the finding. Thus a patient, looking through a + 3.00 spherical glass, may, when apparently converging only 20°, be actually converging 1.5° more.

The measurement of the convergence distance is made very quickly and easily. That of the interaxial distance takes more time and care, but when once made does not, of course, have to be made again.

If desired, the convergence may be estimated in *meter angles*.

All that we have to do in this case is to divide 100 by the base-line convergence distance (PcB) expressed in *cm*. The quotient will be the number of meter angles.

Although useful for some purposes, *e.g.*, in comparing the convergence and the accommodation, the meter angle is not a very satisfactory expression for the amount of effort put forth in convergence. This effort is expressed by the convergence angle, and the latter varies, not only with the convergence distance, but also with the interaxial distance. For example: two patients, both converging to 9*cm*, will have each 11 meter angles of convergence. But if the interaxial distance of one patient is 66*mm*, and of the other 55*mm*, the former will have a convergence angle of 19.8°, the latter an angle of 16.8°, so that, with the same convergence in meter angles, the work done by the first patient is considerably greater than that done by the second.

The principle on which these measurements are based has another application. In a case of complete *convergence paralysis*, the amount by which the divergent deviation (exotropia) increases—and in a case of *divergence paralysis*, the amount by which the esotropia diminishes—as the object is brought from distance down to any point P, theoretically equals double the convergence adduction of a normal eye converging on P, *i.e.* = 2× angle *a*. This would mean that the amount of deviation for distance (measured in degrees of arc not centrads) should be respectively increased or diminished by the following amounts as the test object approaches the eye.

TABLE OF DEVIATION IN CONVERGENCE OR DIVERGENCE PARALYSIS.

To deviation for distance, measured in degrees of arc, add in the case of a convergence paralysis, and subtract in the case of a convergence paralysis, the following:

Distance of Test object	*Interaxial distance*		
	55mm	*60mm*	*65mm*
1 meter	3°	3.5°	4°
0.5 meter	6.5	7	7.5
33*cm*	9	10	11
25*cm*	13	14	15
20*cm*	16	18	20
15*cm*	20	22	24

Usually in either case the difference between the findings for distance and for near points is not so great as theory would indicate, because to the paralysis of one function is superadded an excess of the opposite (convergence paralysis plus divergence excess; divergence paralysis plus convergence excess). Yet not a few cases show a striking conformity with the theoretical demands. Thus one case of divergence paralysis showed:

Test object at	*March Deviation*		*June Deviation*	
	Observed	*Theoretical*	*Observed*	*Theoretical*
5 meters	about 20°	20°	20	20
1 meter	16	17	18	19
⅔ meter			12.5	15
⅓ meter	11	10	10	10
⅛ meter	2	0		

In any case, the measurement of the convergence near point by this method is simple, quick, and accurate, and the determination of the amount by which the eye converges for an object at any distance from the eye is readily and quickly ascertained. Moreover, if the directions as to placing of the zero point of the rule, etc., are carefully observed, the results of any one examination will be comparable with another.

The essential points here desired to be made may be summarized as follows:

1. It is important to measure the distance of the convergence near point precisely, since this measurement gives us our best evidence of the presence or absence of a convergence insufficiency.

2. Obviously, in order to compare the results of observations taken at different times, the measurement should be made in a uniform way.

3. The proper point from which to measure the convergence near point is the mid-point of the base-line connecting the centers of motion of the two eyes. According to the latest researches this means that the measurement should be taken from a point on the nose 9.5*mm* in front of the corneal apex. The distance between this and the convergence near point, plus 25*mm*, is the base-line convergence distance (PcB).

4. To determine the position of the convergence near point itself, a fine white-headed pin or a black dot on a card should be carried along a millimeter scale straight toward the nose until the patient, who is making every effort to converge on the object, sees the latter double, or until the observer himself notes that one eye diverges.

5. The actual angle by which either eye converges (convergence adduction or a) is practically equal to the angle between the two lines drawn from the convergence near point, one going to the mid-point of the intercentral base-line, the other to the point where the base-line intersects the visual axis. If we denote the distance between the visual axes of the two eyes, when both eyes are looking straight ahead (interaxial distance) by i, and the convergence distance (PcB) by p, then

$$\tan a = \frac{i}{p}$$

$$\text{and } a \text{ itself} = \frac{i \times 25}{p} + 1.5^\circ$$

6. The interaxial distance is not the same as the interpupillary distance. To determine it we should proceed according to the definite routine laid down in the text.

7. It is important to make this determination in any case, since it is the interaxillary, and not the interpupillary, distance that should determine the distance between the optical centers of a patient's correcting glasses.

8. The convergence in meter angles, if this is desired, can be determined from the simple relation

$$MA = \frac{100}{p},$$

when MA = the number of meter angles and p is denoted in centimeters. But the meter angle is of less practical importance than the angle a, since the latter is a measure of the actual work that each eye performs in adduction, while a given number of meter angles will, in one person, denote a greater effort, in another, a less, depending on the interaxial distance in each.

9. The determination of the convergence near point finds application in the diagnosis of a convergence or divergence paralysis. In these conditions as the test-object is brought

closer and closer to the eyes the deviation or diplopia increases or decreases accordingly; and theoretically at least the amount by which the deviation increases or decreases bears a quite definite mathematical relation to the distance of the object. The distance may be determined precisely by the method here described, and the corresponding theoretical deviation is shown in the table given in the text. A comparison between the theoretical deviations and the deviations actually found at a series of distances, especially within a meter, may help materially in confirming the diagnosis.

OCULAR TUBERCULOSIS, EXPERIMENTAL AND CLINICAL.[1]

By Dr. WILLIAM C. FINNOFF, Denver, Colorado.

(*With six illustrations on Text-Plates VIII. and IX.*)

FOR many years Colorado has been a health resort for those afflicted with tuberculosis, and a large part of our population is made up of persons who have either gone there for their health, or have followed invalid members of their family. Many of the health seekers have arrested or latent forms of the disease. Persons with tuberculosis expose other members of their household to infection, who in some instances, develop a latent form of the disease. Our incidence of latent tuberculosis is probably proportionately higher than it is in most communities.

With an environment of this kind, we have a fruitful field for the study of tuberculosis in all of its manifestations.

My interest in tuberculosis of the eye was awakened by the study of a case of tuberculosis of the retinal vessels. It was unusual in that the retinal lesions were seen in their very earliest stage of development. This lead me to believe that tuberculosis of the eye is frequently overlooked and that the disease is more common than is usually believed to be the case. Subsequent study and experience have confirmed this opinion.

Reports in the literature of cases of tuberculosis of the eye have increased in number in the last ten years. In the past, tuberculosis has been classified into primary and secondary types. The classification is loosely used and is confusing.

[1] Read before Section on Ophthalmology, New York Academy of Medicine, October 15, 1923.

ILLUSTRATING DR. WILLIAM C. FINNOFF'S ARTICLE ON "OCULAR TUBERCULOSIS, EXPERIMENTAL AND CLINICAL."

FIG. 1. Tuberculous ulcer of bulbar conjunctiva of a rabbit following the injection of tubercle bacilli under the conjunctiva.

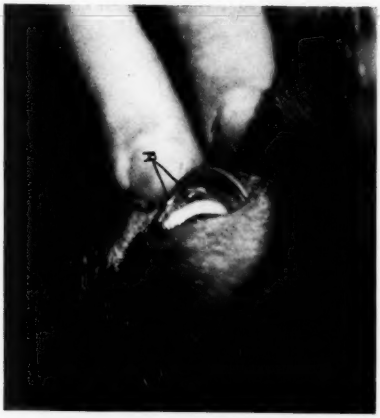

FIG. 2. Tuberculous ulcer of palpebral conjunctiva of a rabbit following the injection of tubercle bacilli under the conjunctiva of the upper lid.

A.—Ulcer. B.—High lights.

FIG. 3. Tuberculous abscess of upper lid of a rabbit following the injection of tubercle bacilli under the palpebral conjunctiva.

ILLUSTRATING DR. WILLIAM C. FINNOFF'S ARTICLE ON "OCULAR TUBERCULOSIS, EXPERIMENTAL AND CLINICAL."

FIG. 4. Fistulous opening in upper lid of a rabbit following the rupture of a tuberculous abscess which was similar to Fig. 3.

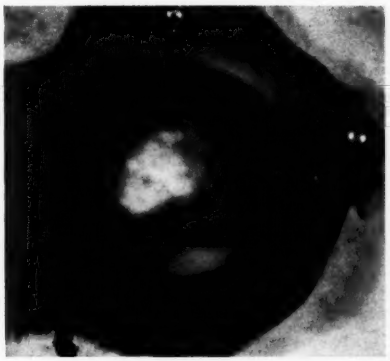

FIG. 5. Tuberculous corneal ulcer with hypopyon following direct inoculation of tubercle bacilli into substantia propria.

FIG. 6. Tuberculous panophthalmitis in rabbit's eye which followed the direct inoculation of tubercle bacilli into the vitreous, Equatorial section.

Some authors classify their cases as primary when no other demonstrable lesion can be found in the body, while others hold that the primary type should comprise only those cases in which the tubercle bacilli enter the eye directly and attack it first before extending to other portions of the body. In the secondary type, some include only those cases in which a demonstrable tuberculous lesion can be found elsewhere, while others insist on classifying all types of ocular tuberculosis of hematogenous origin, as secondary.

It was because of the confusion which exists in classifying, together with a desire to satisfy myself regarding the true nature of ocular tuberculosis, that I began a series of experiments to produce tuberculosis in the eyes of rabbits. The work was started two years ago in the Research Department of the National Jewish Hospital for Consumptives, in Denver.

In attacking the subject from an experimental point of view, a number of factors were first considered. I felt that the technic of producing it should approximate as nearly as possible that which might occur in the living human being. For this reason the following methods were employed:

1. Instillation of emulsions of living, virulent tubercle bacilli into the conjunctival sac.

2. Direct inoculation of living tubercle bacilli into the eyelids, under the conjunctiva, into the cornea, into the vitreous, and into the anterior chamber.

3. Inoculation of emulsions of bacilli into the arterial circulation through the common carotid artery on one side of the neck.

We know that the epithelial coverings of the body are resistent to bacterial invasion. The treponema pallidum of syphilis will not infect the body unless the epithelial covering of the skin, or mucous membrane, is abraded and the subepithelial structures are exposed. The infecting organisms which produce conjunctivitis; *i.e.*, the gonococcus, Koch-Weeks bacillus, the diplobacillus of Morax-Axenfeld, etc., are epithelial parasites and do not penetrate to the tissue under the epithelium. Likewise, before tuberculosis can occur in the eye, the epithelium must first be abraded. In other words, some type of trauma must precede the infection.

When we consider the infrequency of infection of the mouth

and throat in patients with active pulmonary tuberculosis whose buccal and pharyngeal mucous membranes are constantly bathed in secretion which contains millions of tubercle bacilli, it seems unlikely that infection of the eye could occur from organisms in the dust, etc. The eye is constantly bathed in tears, and foreign matter is washed away quickly.

Our experiments tend to confirm the view that infection does not occur through unabraded epithelium. In the first series, twenty-five animals (fifty eyes) were exposed by instilling concentrated emulsions of virulent living tubercle bacilli into the lower cul-de-sac. The eyelids were held away from the eyeball for two to ten minutes, so that the emulsion would remain in contact with the conjunctiva and not be washed away by the tears. Lesions of the conjunctiva did not occur in a single instance.

In the second group of experiments, the conjunctiva was either incised with scissors or crushed with forceps, and emulsions of virulent bacilli were then instilled under the same conditions as mentioned above. In five of the fifty eyes, tuberculous granulomas developed in the injured area. They all healed in a short period of time leaving scars without further involvement of the eye or body.

In the next series, emulsions of living bacilli were injected under the bulbar conjunctiva, and in every instance a tubercle developed at the site of the injection. The involved area became slightly reddened in the beginning and in a week, a localized tuberculous abscess had formed. This continued to increase in size, eventually ruptured, and discharged its contents into the conjunctival sac. A punched out ulcer with irregular edges and a base of granulation tissue which was covered with a dirty gray membrane resulted. The ulcers healed without treatment and left scars. The same change occurred when emulsions were injected into the palpebral conjunctiva.

When emulsions were injected into the substance of the lids, the tubercles were slower in their development. They varied in size and finally ruptured through the skin or mucous membrane. Fistulous openings which communicated with the abscess cavity usually persisted for a long period of time. They finally healed and left scars which distorted the lid. No

signs of tuberculosis were found in other parts of the body of animals that were so treated.

After injecting emulsions of bacilli into the stroma of the cornea, an ulcer usually developed. In several cases, a hypopyon occurred in the anterior chamber. The ulcers were not unusual, and with the exception of a scar, the cornea healed without complications.

Endophthalmitis or panophthalmitis always occurred after living bacilli were injected into the anterior chamber or vitreous.

The inference that one naturally draws from these facts is that intraocular tuberculosis, in the great majority of cases, is hematogenous in origin and must be secondary to a tuberculous focus elsewhere in the body. How then does it extend from the primary focus to the eye? I believe the primary focus in man is often in the bronchial lymph nodes. It may be in the lung or elsewhere. Bacilli are carried from the lesions by leukocytes or by the lymph into the lymph channels. They eventually reach the venous system through the thoracic duct, pass through the heart and lungs and enter the arterial circulation and are carried to the eye.

Stock (1) produced tubercles in the eye by injecting bacilli into the auricular vein of rabbits. I have seen tubercles in the iris of rabbits after this method of injection. However, tubercles are more easily produced in the eyes of animals when emulsions of bacilli are injected into the arterial circulation. The technic that we followed was published in the *Transactions* of the American Ophthalmological Society, 1922. Briefly, it is the introduction of an emulsion of coarsely ground bacilli into the common carotid artery of animals on one side of the neck. When living bacilli were used, all animals developed ocular tuberculosis on the side that was injected. The character of lesions produced in this manner, were described in a paper read before the American Ophthalmological Society at its last meeting. It is an interesting fact that tubercle bacilli killed by heat, produce lesions similar to those that occur after the injection of living organisms. We have inoculated a large series of animals in this manner, and a report of our findings was read before the last Colorado Congress of Ophthalmology and Oto-Laryngology and will be published

in the *American Journal of Ophthalmology* in the near future.

We have produced practically all types of ocular tuberculosis in animals, that occur in the human eye. The tubercles of the lid of hematogenous origin, were similar in appearance to those that occurred after direct injection of bacilli under the conjunctiva. They were usually multiple and were replaced by scar tissue after they had healed.

These findings support Lundsgaard's (2) contention that tuberculosis of the conjunctiva and lids is usually of hematogenous origin and is of the secondary type. Igersheimer (3) contends that tuberculosis of the conjunctiva is always primary. He bases his theory on the results of his experiments. He injected tubercle bacilli under the conjunctiva and produced ulcers which were accompanied by enlargement of the preauricular lymph glands. Our series of animals in which the inoculations were made subconjunctivally, paralleled Igersheimer's experiments, and the same changes occurred also after hematogenous infection.

In animals, the distribution of tubercles in the conjunctiva is similar to that of human beings. Ulcers occur more frequently in the palpebral than in the bulbar conjunctiva. Clinically, they resemble and run a course similar to the lesions which occur in man. A lesion resembling a phlyctenule only occurred once in the whole series of experiments. It was associated with severe iritis. This experience does not support the contention held by many clinicians, that phlyctenules are tuberculous in nature. Further investigation must be carried on to determine the true nature of phlyctenular disease.

I have never seen a case of corneal tuberculosis in my clinical experience, that I felt certain was of primary origin. Experimentally, I could only produce primary lesions in the cornea by injecting bacilli directly into the substantia propria. However, changes in the cornea occurred frequently after the injection of tubercle bacilli into the arterial circulation.

The changes that occurred in the cornea could be divided into two groups; *i.e.*, early and late. The appearance of the corneal changes are described in the paper on Dead Bacilli.— Only the late changes resemble human corneal tuberculosis. There were deposits on the posterior surface of the cornea

which resembled cold mutton fat. Grayish colored infiltrates appeared in the substantia propria, that persisted for many weeks. The corneal substance remained avascular and there was very little circumcorneal injection. Sclerosing keratitis also occurred and ran a clinical course that paralleled the same condition in man.

We have failed in our attempts to produce primary intraocular tuberculosis except by injecting bacilli directly into the anterior chamber or vitreous. Secondary, or hematogenous intraocular infection occurred repeatedly after injecting organisms into the arterial circulation. Diffuse iritis, miliary and conglomerate tubercles were common forms. When dead bacilli were used, the lesions healed and left scars. The miliary and conglomerate tubercles were yellow or gray in color and ran a very chronic course. Frequently blood vessels developed and ran over the surface of the nodules. The nodules healed and left gray patches of atrophy in the iris. I have seen cases of tuberculosis in human beings, that were similar to those that occurred in the eyes of rabbits.

The choroid is a favorite site for the lodging of bacilli and the development of tubercles. Typical areas occurred and could be studied with the ophthalmoscope. The fundus changes were identical to those seen in man. Both the isolated and disseminated forms of choroiditis occurred. The progress of the tubercles were carefully studied with the ophthalmoscope. Eyes were enucleated at regular intervals and sectioned. This enabled us to note the microscopic changes. Both the ophthalmoscopic and microscopic changes in the eyes of animals correspond to those in the eye of man, and our experiments confirm Stock's (4) contention that uveitis is frequently tuberculous in nature.

Tuberculosis of the retina *per se* only occurred twice in our series of experiments. The disease was confined to the perivascular lymph spaces, but there were no hemorrhages into the retina or vitreous. Extension into the retina occurred frequently from the choroid. A conglomerate tubercle of the optic nerve developed once.

Episcleritis did not occur frequently and scleritis was usually confined to the cases with severe uveal disease.

Our experiments have enabled us to study the true nature

and clincial course of tuberculosis in the eye. We have obtained valuable data regarding the incubation period and progressive changes in the various types of ocular tuberculosis. With this data we hope, in the future, to be able to accurately determine the diagnostic and therapeutic value of tuberculin and other agents.

I am indebted to Doctor H. J. Corper, Director of the Research Department, for many valuable suggestions, and his kindly coöperation.

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BILATERAL DETACHMENT OF THE RETINA IN TWO SUCCESSIVE PREGNANCIES.[1]

By Dr. EMORY HILL, Richmond, Va.

A WOMAN, aged 28, was delivered of her first baby in November, 1917. Her blood pressure and urine were normal, and Wassermann negative. Pregnancy was uneventful until the day before labor began, when she was nervous, developed delusions of persecution, and had to be committed to an asylum for the insane for a period of several months. Two subsequent pregnancies resulted in two normal babies which have lived. This history was obtained from the obstetrician, Dr. M. P. Rucker.

On November 9, 1921, I was asked to see this patient in the obstetrical ward of the Virginia Hospital where she had been admitted in the sixth month of pregnancy in a pre-eclamptic state, with generalized edema, blood pressure $\frac{245}{140}$, albumen and casts. Vision had been failing for one week and was reduced to light perception. Both retinas were detached in the lower half, reaching forward 10D., with flat detachment above, much retinal edema, exudates and hemorrhages, and slight swelling of the nerve heads. Immediate delivery was advised and carried out by the obstetrician, Dr. Greer Baughman, by means of the Vorhees' bag. Twin fetuses were born and died in a few hours. The detachments increased in the next forty-eight hours, when scleral punctures were made. Three days later the right retina was almost in situ and the detachment of the left had subsided from 10 to 8D. Blood pressure fell to $\frac{180}{130}$. She left the hospital two days later, contrary to advice. When seen at her home in the country one week afterwards, only flat detachments were found far forwards and the edema and hemorrhages were less. Vision was fingers at 5 feet. She had been out of bed attempting to care for her children and could not be persuaded to do otherwise nor to report later at the dispensary. Nothing more

[1] Read at meeting of American Ophthalmological Society, Colorado Springs, Colorado, June 20, 1923.

was heard of her until the complications of another pregnancy forced her to the hospital.

On April 25, 1923, I was asked to see an eclamptic patient in the Sheltering Arms Hospital complaining of blindness. This proved to be the same woman, again in the sixth month of pregnancy, with generalized edema, blood pressure $\frac{2}{1}\frac{4}{4}\frac{0}{0}$, albumen and many granular casts; she had had two convulsions and had apparently been blind for two weeks. The conjunctivæ were chemotic, the pupils 5*mm* wide and fixed, the retinas detached, the right elevated 10D. below, reaching nearly to the disc, and 5D. above, the left 12D. above and below, leaving a narrow cleft through which the disc could be seen. The undetached portions were edematous, a few hemorrhages were seen, and the nerve heads were white with considerable exudate and irregular edges. The retinal arteries were very narrow and the veins were greatly engorged, suggesting thrombotic obstruction. Immediate delivery was advised and carried out by the obstetrican, Dr. M. P. Rucker, by means of the Vorhees' bag. A six months' fetus was born alive but died in a few hours. The next day three scleral punctures were made beneath the high detachments, one in the right eye and two in the left. Gradual subsidence followed in the next 48 hours (from 12 to 8D) and the blood pressure decreased to $\frac{2}{1}\frac{0}{2}\frac{0}{0}$. No return of vision had occurred at this time when the patient refused to stay longer in the hospital despite the urgent warnings of the obstetrician and myself. The sad circumstances of this case were made worse by the poor mentality of both the patient and her husband who insisted that vision would return when they could reach home and use an eye wash. On May 29th, Dr. Jos. A. White saw this patient and found the following condition: both eyes blind, tension normal, pupils dilated and fixed; scars of former retinitis, and secondary atrophy of nerves; retinal veins normal in the central area but contracted at the periphery, arteries extremely narrow; no detachment in the right, but a detachment on the nasal side in the left covering the disc.

Despite the tendency of such detachments to subside after delivery it seemed safer to do scleral punctures and release the subretinal fluid promptly. There was very little prospect of vision after the last pregnancy because of optic atrophy, but it was hoped that the blindness might be in part cerebral and some return of vision possible if the retinas could be reattached in a short time.

The recurrence in a second pregnancy is unique so far as I can discover in the literature. Clapp (1) refers to a case of

Baduel, mentioned by another writer as an example of slight detachment recurring in five succeeding pregnancies; but this is a mistake. Baduel's (2) original report deals with recurrence of slight retinal detachment at several menstrual periods.

The text books make only brief mention of this condition and references in the journals are comparatively few. Polte, for example, discussed the subject of eye lesions in pregnancy and the puerperium in 1906, on the basis of 200 cases examined, and did not mention retinal detachment. Other lesions associated with eclampsia and nephritis of pregnancy are frequently noted, but detachment is inconspicuous among them. Probably this occurs more often than we have believed. The attention of obstetricians is directed to eclampsia or nephritis and eye grounds are not always examined. Slight detachment far forwards may not be detected without wide dilatation of the pupils, especially in the presence of convulsions, and it may recede before post-partum examination is made. In 12 years I did not see this occurrence, whereas three cases have come under my observation, and another has been seen by a colleague, Dr. W. L. Mason, in a space of eighteen months since an examination of eye grounds has been made a routine in the study of the toxemias of pregnancy in the obstetrical wards. Clapp (1) saw six cases in a similar period in the maternity wards in Baltimore, though he had not seen any cases previous to 1917. Bernard (3) refers to 24 cases occurring with the retinitis of pregnancy, all of which subsequently showed reattachment, some recovering normal vision. In this country, Wadsworth (4), Greenwood (5), Cohen (6), Posey (7), and Blake (8) have reported single cases. R. Foster Moore (9) collected 17 cases and refers to Heilbron's report of 21 cases. Moore summarizes his conclusions, from a most thorough review of the subject, as follows: detachment is by no means an uncommon complication of renal retinitis and is especially frequent in the retinitis of pregnacy. It is usually bilateral (40 of 44 cases); nephritis in the absence of retinitis is not a cause; the liability to detachment is in proportion to the severity of the retinal changes; it does not depend upon the presence or absence of general edema; the immediate cause is a subretinal exudate which is derived from the retina and not the chorioid; the appearance differs according as the exudate is solid or fluid

(flat or lobulated detachment). If the patient recovers, reattachment occurs, unless gross tears allow the vitreous to pass beneath the retina. After recovery permanent visual defects and fundus changes probably always remain. The intraocular tension is not raised.

Schiötz (10) has recently reviewed the subject in great detail. Of 680 patients in the Christiania Clinic, 132 were eclamptic and 26 pre-eclamptic. Twenty-seven of these had retinitis or papilloretinitis, 4 of whom had retinal detachments. Recoveries were remarkable. Twenty cases which could be followed showed perfect health, without albumen or increased blood pressure, though 13 had become pregnant again. Schiötz considers the prognosis for sight good in those who survive the eclampsia, though he seems to regard retinal detachment as the chief source of permanent visual loss. He found evidence of nephritis largely a concomitant of pregnancy, being generally absent both before and after the pregnancy. This supports the opinion prevailing to-day, as expressed by Black (11), that the retinitis of pregnancy is not albuminuric, nor a true inflammation, but it is the result of syncitiotoxins which are not eliminated.

Generalized edema is frequent in eclampsia, and cerebral edema is sometimes conspicuous. Baehr (12) believes that the latter explains the coma and convulsions. Zangemeister (13) has reviewed the various theories advanced to account for eclampsia and gives convincing arguments for believing it to be due to cerebral edema. He draws a close parallel between the symptoms of increased intracranial pressure, seen clinically and produced experimentally, and those of eclampsia and states that he has observed the edematous brain after trephining the skulls of eclamptic patients. Lumbar puncture has been practiced and advised by Wilson (14) and Snyder (15). Clapp refers to the similarity of the fundus picture seen in the toxemia of pregnancy (blurred disc edges and retinal edema) to that seen in cerebral edema accompanying fractures of the skull.

It has long been a dictum of ophthalmologists that threatened blindness demands the induction of labor. A further suggestion of value to the pregnant woman is that examination of the eye grounds should be made in every case

of toxemia of pregnancy and this should be done with mydriasis. The presence of marked edema, intraocular and intracranial, suggests the propriety of lumbar puncture in addition to the interruption of pregnancy for the more rapid relief of eclamptic symptoms.

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SYNCHYSIS SCINTILLANS IN THE ANTERIOR CHAMBER. A CASE REPORT.

By Dr. JOHN N. EVANS, Brooklyn.

(With one illustration on Text-Plate X.)

Case of P. N.

ON December 24th of 1921 a carpenter presented himself, complaining of pain and redness of his right eye, which had resulted from a blow by a chip of wood. The man, a native of the United States, was 29 years old.

The previous hsitory proved to have a most significant relation to the present condition. Twelve years ago, when shooting off a gun, a piece of the percussion cap flew back and stuck into his right eye below, and slightly to the outside of, the cornea. He was able to withdraw this fragment, though it was quite deeply imbedded. He was treated by his family physician for a few days. His eye was red and painful only for a short time. After that he went to a New York Infirmary, where X-ray pictures were taken of his eye. (He does not know what these pictures showed.) He received treatment at that hospital for a week, and neglected to give his eye further attention. He states that immediately after the accident, when closing his uninjured eye, all objects had a brownish color. Later he noticed bug-like black objects floating before it as in a mist. His vision gradually decreased during the next four years as his pupil became milky, and then white in color. Four days ago, while chopping wood, a chip struck the closed eyelid of the same eye with considerable force. There was severe pain for an hour or two and the eye became very red. His family told him that his pupil had suddenly become black again. Home remedies were applied and the patient experienced increasing pain, particularly at night.

Examination brings out that there is slight swelling of the upper eyelid with a small area of ecchymosis. There is no

ILLUSTRATING DR. JOHN N. EVANS'S ARTICLE ON "SYNCHYSIS SCINTILLANS IN THE ANTERIOR CHAMBER. A CASE REPORT."

disease of the lacrimal apparatus. There is both deep and superficial pericorneal injection. The cornea is transparent except directly below, and slightly towards, the temporal side, where there is a fine linear scar—following the curve of the limbus for about 3 millimeters. The brown iris is tremulous and its markings are indistinct. The pupil is slightly oval in an oblique direction (a line running from VII to I—clock-face topography). The anterior chamber is deep, and even by gross inspection is seen to be clouded by great numbers of minute scintillating bodies, which, on rotation of the eye, move, for the most part, in vortex-like whirls, issuing from the pupillary aperture, similar to the rings (smoke) of a tobacco user, and impinging on the inner concave surface of the cornea, and curling backwards and outwards toward the iris angle. There is also a spiral motion to this flow.

Under strong oblique illumination and examination with the loupe the entire anterior chamber is seen to be occupied by minute crystalline bodies. They vary, decidedly, in size, from barely discernible points to relatively large flat polygonal plaques. They all reflect prismatic colors—red and green predominating, with a flash of yellow. The fluid in the anterior chamber is of quite watery consistency as motion of the crystals is very rapid. There is no definite distribution of the crystals when the eye is at rest, though there is a tendency for the larger ones to form a ring-like collection about the central point of the cornea, and also to collect in the region of the iris angle. There is a sparse deposit of crystals over the entire endothelial layer of the cornea, which seems to be slightly imbedded or adherent, as it is not disturbed by motions of the eyeball. With the tremor of the pupillary border of the iris, small currents seem to be set up and impel the crystals so as to give the effect of continuous scintillation at the margin of the pupil. Ophthalmoscopic examination gives no fundus reflex or other information. There is no light perception. The left eye is normal in all respects. Atropine and hot applications were prescribed.

Examination on December 27th shows the pupil has dilated but slightly under the influence of atropine. No other changes are evident than those found at the previous examination, except that intraocular tension has risen to + 2 by palpation. The patient has had severe pain the last 48 hours, relieved only by ten-grain doses of aspirin. Treatment continued. Examination on January 5th shows the tension and pain reduced. No other changes are in evidence. Paracentesis was suggested to the patient. (He has not returned for further treatment.)

An explanation of this unusual phenomenon might be that the first injury, besides damaging the lens, caused an intraocular hemorrhage which, in the process of repair, resulted in the formation of the cholesterin crystals (Synchysis Scintillans). With the recent injury and preceding liquefaction of the vitreous, the fluid vitreous was allowed to mix with the aqueous,—due to the luxation of the cataractous lens. This made a direct passage for the fluid contents through the pupil, and permitted a flow of the liquid with each motion of the eyeball. There seems to be no tendency on the part of those crystals deposited on the posterior surface of the cornea to assume the pyramidal formation characteristic of "Descemet's deposits."

To see in a fellow-creature's eye a most startling shine and glitter, as from the facets of a perfect diamond, calls to the most primitive tongue the question of "what and why." These cases were, perhaps, more frequent in early times than now, on account of the practice of couching cataractous lenses. All available literature has been reviewed in an effort to bring together, in usable form, such reports as have been presented.

Gautier, in discussing theories of his time and earlier, points out some very interesting views, thus: Parfait Landrau (1828), in speaking of these changes in the vitreous, says older observers considered it an optical illusion. He does not attempt to explain it himself. Desmarres, following (1846), gave the name to the condition and believed it had its origin in minute irregularities of the vitreous, which reflected the light from the points of its prominence and refracted it irregularly. Petroquin (1846) considered it due to a veil-like change in the vitreous. Sichel (1846) thought the phenomena due to changes in the vitreous, causing irregularities in its density, and so of the refracted light. Bousseau—though never having seen a case—thought it might be due to cholesterin crystals. Tavignot—having noted the frequency of associated cataract—argued that unabsorbed scraps of lens material produced the phenomena. M. Stout (1846)—incidentally of New York—however, made the first adaptation of the microscope to the living eye, and demonstrated, without doubt, the real character of the phenomena by actually

identifying the crystals in the vitreous as cholesterin. He was able to show that this was refraction as well as reflection.

The early investigators had to content themselves largely with philosophical speculations as to the nature and source of the glittering particles and, in consideration of their inadequate facilities for investigation, we must admit their advance in an understanding of the condition was praiseworthy.

It is not the purpose of this paper to discuss the entire problem of cholesterin formation in the eye, nor to consider its significance—very masterful discussions of these phases have been quite recently presented.[1] The title is slightly deviated from, however, as will be noted, for, since synchysis refers to fluid vitreous, some of the cases evidently did not derive the crystals by a direct passing of the body into the anterior chamber.

To summarize the main features of the problem is, however, desirable.

I.—Cholesterin, or cholesterol, was discovered in 1775 in gallstones by Conradi.

II.—J. A. Schmidt was the first to demonstrate its presence in the eye (lens capsule and anterior chamber).[2]

III.—Cholesterin is found in solution in small amounts in almost all animal tissues.

IV.—Cholesterin belongs to the trepene group (the formula being C_{26} H_{43} O H) and is evidently the result of retrogression in the metabolism of albumen.

V.—Bile has the faculty of preventing the accumulation of cholesterin in the body under physiological conditions.

VI.—Accumulation of cholesterin occurs pathologically in all organs through delayed absorption of hemorrhages, exudates and fluid effusions. Its accumulation is necessarily dependent upon the amount of albumen present.

VII.—In the eye cholesterin crystal formation occurs:

a. In the choroid and retina—usually with detachments of the retina in the sub-retinal fluid.

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[1] Particularly, Westphal, *Archiv f. Augenheilk.*, lxxviii., p. 1, 1915.

[2] Although this case was not published until 1830 it is evident that it was reported sometime previous to 1828.

b. Vitreous
   Is primarily only a senile type on account of the low albumen content of the vitreous, but occurs secondary to other processes.
c. Lens—
   Associated with metabolic changes of cataract formation,—different proportions in nucleus and cortex.
d. Iris and ciliary body—
   Occurs after hemorrhages and inflammatory exudates.
e. In the cornea.
f. In the anterior chamber after
   1. Hemorrhages
   2. Inflammatory exudates of iritis
   3. Delayed absorption of hypopion.
   4. A product of retrogressive metabolism of cataractous-lenses, vitreous and cornea (very rarely from the cornea).
g. Combinations of these.

It must be remembered that the effect of scintillating pupil may be produced when the crystals are within a transparent lens capsule. Such was evidently the case of Desmarres, Bousseau, Roberts and many others. It is not proposed to consider their reports.

The extreme rarity of this condition is only realized in reviewing the literature when each author is careful to point it out. The papers of Gautier and Leber are particularly praiseworthy and, though Heilborn's paper represents a very complete review of the literature, he was only able to cite a few reports dealing with crystals in the anterior chamber. His bibliography is impossible to use, in some instances, on account of omissions of source. The following summary of previously presented cases is only possible in outline form, as a more detailed study is impossible on account of insufficient data.

AUTHOR	EYE	AGE	SEX	OCCUPATION	PREVIOUS INJURY	PRESENT VISION	PATHOLOGY	AUTHOR'S REMARKS AND THEORIES
I. SCHMIDT, J. A. Previous to 1828	O. S.	Young	F	Peasant		Blind (total) years.	Calcareous degeneration of lens, crystals in and on anterior capsule.	Later opened capsule and saw the crystals escape from liquified lens. (Crystals collected after operation—reddish grains.)
II. GAUTIER, J. 1848	O. S.	18	M	Shopkeeper	14 years previously.	?	Dislocated traumatic cataract, old iritis, crystals ant. and post. chamber.	A good review up to his time and discussion of older theories in general.
III. SICHEL 1849 or 1844	O. D.	25 ?	M	None	Iridocyclitis (hypopyon) years.	Blind (total) years.	Organized membrane full of crystals.	He had seen this case in 1844. Crystals were in aqueous then.
IV. GUNSBURG 1850	O. U.	65	M	Cotton Printer	Penetrating globe years before.	Large objects years.	Lens clear but dislocated; crystals pass in and out of pupil.	First saw patient in 1845 and seems to have reported it at that time. He refers to similar cases in his work on pathology, Vol. II., page 164. The other eye showed iridocyclitis but no crystals.
V. SICHEL 1850	O. S.	29	M	?	Crystals in vitreous, no injury. Iridocyclitis years duration.	Blind (total) years.	Crystals passed from the vitreous around lens to aqueous. Exudate and synechia.	He seems to have made the first microscopic study and chemical analysis. His paper is carefully worked out and seems reliable.
VI. DIX 1853	O. D.	32	M	None	No injury, repeated cataract needling, fundus disease 10 years +.	Light perception past 10 years.	Crystals in and out of pupil.	He thinks that the fundus disease was tubercular.

AUTHOR	EYE	AGE	SEX	OCCUPATION	PREVIOUS INJURY	PRESENT VISION	PATHOLOGY	AUTHOR'S REMARKS AND THEORIES
VII. WINDSOR 1870	O. D.	27	M	Laborer	Struck with stone 5 days previously.	Blind (total) 5 days.	Hyphemia followed by crystals, details obscured.	The eye went into phthisis bulbi. He considered the crystals to be small fragments of the disintegrated lens mixed with blood.
VIII. STRAWBRIDGE 1873	O. S.	16	M	School	Penetrating iron splinter. Years previously.	Blind (total) ?	Bone formation, old hemorrhages, calcareous lens, crystals throughout.	The eye was sectioned and carefully studied; there was bone formation, evidence of hemorrhages and cholester in crystals throughout.
IX. HIRSCHBURG 1874	O. S.	?	M	?	Injury years	Blind (total) years.	Detached retina, dislocated lens. Crystals in vitreous and aqueous.	He had heard of such a case previously and refers to the reporter as Knapp, but gives no initials or source.
X. DESPAGNET 1880	O. S.	50	M	Stoneworker	Stone struck eye one year.	Blind 35 years.	Cataract, crystals anterior chamber only.	Eye was sectioned and examined. General picture was that of phthisis bulbi.
XI. SCHOLER 1880	?	23	M	?	Stabbed with awl one year ago.	Light perception.	Atrophy bulb, lens absorbed, crystals passed through pupil.	He believes crystals came from the vitreous.
XII. LEBER—1895 Case 1.	O. D	9	M	School	Repeated discissions for congenital cataract.	Fingers 1 M.	Iritis followed operations.	A most complete discussion and unusual paper. Has collected more cases than any other.
Case 2.	O. D.	42	M	Woodsman	Struck in eye 18 years previously by iron splinter.	Total blindness.	Traumatic cataract.	

AUTHOR	EYE	AGE	SEX	OCCUPATION	PREVIOUS INJURY	PRESENT VISION	PATHOLOGY	AUTHOR'S REMARKS AND THEORIES
Case 3.	O. S.	18	M	?	Injury one year previously.	Total blindness.	Iritis and cataract?	
Case 4.	O. S.	57	M	Laborer	Protracted inflammation 8 years previously.	Total blindness.	Iritis and glaucoma.	
XIII. INGALLS 1898	O. S.	36	M	?	Struck eye 12 years previously. Repeated needlings for cataract.	Light perception.	Crystals in aqueous and vitreous.	Comments on the lack of similar cases in the literature.
XIV. NEEPER 1908	O. D.	49	F	Housework	Operation 5 years previously for cataract.	Blind (total).	Atrophic bulb, crystals anterior chamber.	The patient was myopic. Lens was cataractous at the early age of 29.
XV. HEILBORN 1915	O. D.	?	M	?	3 operations for detachment and iridectomy years ago.	Blind (total).	Old chorio-retinitis, detached retina, high myopia, crystals throughout all tissues. Cataractous lens.	The most elaborately worked up case, from the pathological standpoint, as well as giving an elaborate review of the literature. His bibliography, however, is incomplete and impossible to use in certain instances because of the incompleteness of the reference. Case was not primarily his own.
XVI. MARPLE 1916	.....	.....	.....	.....	.....	.....	.....	The only note is that he observed such a case once in a blind eye. Refer to Ophth. Sec. of N. Y. *Annals of Med*, Jan., 1916.
XVII. BOEHMIG 1921	?	?	?	?	Repeated intraocular hemorrhages over a number of years	Blind (total).	Detached retina, atrophy of bulb and crystals in anterior chamber. Aphasia.	

SUMMARY OF THE (20) TABULATED CASES

I. The Eye Affected—
- Right ..... 7 cases.....
- Left ..... 9 cases.....
- Not designated ..... 3 cases.....
- Both ..... 1 case.....

II. Age of Patient—
- Youngest ..... 9 years
- Oldest ..... 65 years
- Average ..... 33 years
- Not stated 5

III. Sex of Patient—
- Females ..... 2 .....
- Males ..... 16 .....
- Not stated 2

IV. Occupation—Diverse

V. Duration of Injury—
- Shortest time ..... 5 days
- Longest time ..... 18 years
- Usually stated as of "years" duration

VI. Nature of Lesion—
1. Traumatic—
   - Accidental ..... 10 .....
   - Operative ..... 4 .....
2. Inflammatory ..... 5 .....
3. Not stated 1

VII. Final Vision—
- Total blindness ..... 14 .....
- Light perception ..... 3 .....
- Large objects ..... 2 .....
- Not stated 1

VIII. Lens
(Traumatic and cataractous)—
- Injured ..... 13 ....
- Clear ..... 1 ....
- Indefinite or not stated 2

Uveal inflammatory (non-traumatic) 4 ....

Present reported case not included.

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POSTERIOR TRANSILLUMINATION OF THE EYEBALL.[1]

By Dr. GEO. S. DERBY, Boston, Mass.

(With two illustrations on Text-Plate XI.)

IN 1913, at the meeting of this Society, Lancaster described an instrument for the transillumination of the eyeball posterior to the equator. This consisted of a small flexible metal tube with a minute lamp at the end which is completely surrounded by metal except for one small opening at the tip.

So far as I have been able to ascertain posterior transillumination of the eyeball, up to the present time, has only been employed by means of a powerful light introduced into the mouth, a much less certain means of diagnosis than with an instrument of the foregoing construction. For this reason I may be permitted to show again Lancaster's transilluminator and to report a case in which it was very helpful in making the diagnosis.

Last winter, through the courtesy of Dr. E. T. Easton, of Boston, I saw the patient, a young woman of twenty-five, who presented a localized separation of the retina just above the disc and overhanging it so that its upper half was obscured. The separation was of a slightly grayish color, its summit was best seen with a +12 glass in the ophthalmoscope. It extended forward steeply from the center of the disc and faded away into the normal retina above and at the sides. In the separation were a number of tortuous venous loops and below the disc and in no way connected with the separation were similar loops apparently connecting directly an artery with a vein. This appearance

[1] Read at meeting of American Ophthalmological Society, June 20, 1923, Colorado Springs, Colorado.

ILLUSTRATING DR. GEO. S. DERBY'S ARTICLE ON "POSTERIOR TRANSILLUMINATION OF THE EYEBALL."

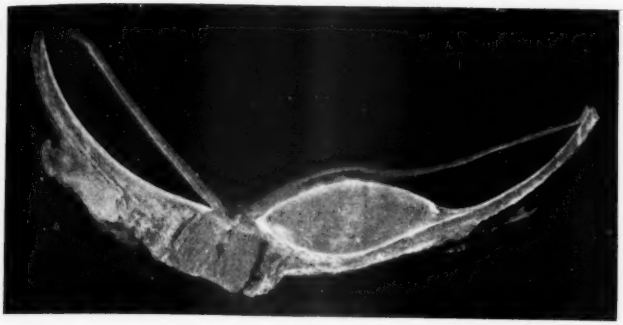

FIG. 1.

FIG 2.

of these vessels was quite striking. They could hardly be due to the influence of the new growth, as they were just as marked below the disc and some distance away from the tumor as they were over its surface. There were a few pigment spots down and in from the disc. The vision of this eye, the left, with correction was $\frac{6}{9}$, the other eye was normal. Tension R 14*mm* L 10*mm*. The field of vision showed a scotoma corresponding to the separation.

With Dr. Easton's approval posterior transillumination was carried out. An incision was made through the conjunctiva between the superior and external recti about 15*mm* back of the limbus. Tenon's capsule was incised and the transilluminator, which had been sterilized in alcohol, introduced. It was very easily passed to just above the optic nerve and a small area was easily and beautifully demonstrated in the posterior wall of the eyeball which was nearly impervious to light. The procedure was carried out under anæsthesia, by means of an orbital injection of novocain, with little or no discomfort to the patient.

The eye was enucleated the next day by Dr. Easton and a small sarcoma of the choroid demonstrated by Dr. Verhoeff to whose courtesy I owe the slide which I am passing around.

The tumor measured 6 x 7 x 3*mm*. It reached the upper disc margin and was situated entirely within the choroid. It was composed of unpigmented spindle cells. The veins of the nerve head were greatly distended and contained an abnormal number of polynuclear leucocytes. Arising from several points on the surface of the disc there was a small amount of neuroglia tissue containing thin walled blood vessels. These vessels continued over the surface of the retina almost to the macula and for an equal distance in the other directions. They suggested to Dr. Verhoeff persistent remains of the embryonic hyaloid system.

The correctness of this explanation is, I think, open to some doubt.

Dr. Lancaster's transilluminator has been in my possession for some years past waiting for such a case. It will never be used very frequently in any man's practice but when the occasion arises it will be found very valuable.

A college professor of forty years was seen in consultation. He presented a pigmented area in his fundus just outside the macula region which showed a slight elevation but no separation of the retina. The eye had normal vision. He was next seen by an eminent colleague in an eastern city who suspected tuberculosis. As the area increased in size and elevation and vision began to fall during the succeeding months it was decided to enucleate. The patient's oculist asked me to remove the eye which I did and a glass ball was

implanted. A small flat sarcoma of the choroid was found, and under the microscope, one of the ciliary nerves emerging from the eye ball was found to be surrounded by tumor cells.

A secondary operation was then performed and a certain amount of orbital fat in the muscle cone removed. The glass ball was reinserted and has remained in situ. The cosmetic result is fair.

Had the posterior transilluminator been used in this case, diagnosis would have been made some months earlier, the future safety of the patient would have been better assured, the necessity of a second operation would have been avoided and a better cosmetic result would have been obtained. I believe the instrument to be of real value in a certain group of cases.

ONE HUNDRED CATARACT OPERATIONS PERFORMED IN ONE DAY AT SHIKARPUR, SIND, INDIA.

H. T. HOLLAND, M.B., F.R.C.S.E., QUETTA, BALUCHISTAN, INDIA.

BEFORE proceeding to describe the one hundred cataract extractions performed in one day, it may be interesting to give some account of the Clinic, and the very adverse circumstances under which the operations were performed. The Clinic can best be described as an eye camp, lasting for six weeks each year (January 1st to February 15th), during which some eight thousand cases were dealt with.

There are no regular wards for the accommodation of the patients, but only a series of sheds or shelters where the patients lie. Anyone familiar with the East, knows what a caravanserai is like. Our wards are just like a large rambling caravanserai, which accommodates about one thousand people. Dust storms are by no means infrequent and the dirt finds its way right through our wards. Each patient is attended by one or more relatives who look after him, and not infrequently look under the bandage to see how the eye is progressing. At our busiest time we have between 600 and 800 in-patients, and as we have only two English sisters and three ward orderlies as dressers, efficient supervision is out of the question, and yet, in spite of the many disadvantages, our end results are very satisfactory. This year we operated on 1322 cataracts.

The conditions under which the patients live at home are far from sanitary, and many of the eyes operated upon would be rejected as inoperable by many operators, if statistics were more important than the welfare of the patient.

HISTORY: One great difficulty we have to face is the impossibility of arriving at anything approaching a true history. The patients and their relatives will often wilfully mislead us, from the fear that if they give a true history, we would decline to operate. Many hopelessly blind patients often declare they have perception of light, and often make fairly accurate guesses at finger counts. Others again have an idea that if they would admit they have perception of light the doctor will reject them because the cataract is not ripe. For this reason, several cases each year, surgically perfect, have no vision, and an ophthalmoscopic examination reveals various fundus changes, such as retinitis pigmentosa, optic atrophy, etc.

TRACHOMA: Another foe with which we have continually to fight is trachoma. Trachoma with all its sequelæ and complications is the rule, and it is exceptional to find an eye free from all traces of this disease. The greater majority of these cases are passed on to the operating room on the day of admission, and certainly not more than 2% are kept back for treatment of the trachomatous condition before operating.

GLAUCOMA: Glaucoma is also extremely prevalent in Sind, and a large number of our cataracts have plus tension. This year out of a total of 7800 new out-patients, there were 702 cases of glaucoma, or about 10%. We operate on many of these cases provided there is perception of light, and in many cases with striking success, although in a few choroidal hemorrhage occurs.

These few preliminary remarks are made to give some rough idea of the disadvantages under which the work in Shikarpur is done.

Three hundred seventy-seven new cases applied for relief January 22, 1923, of which 267 were eye cases as follows:

Cataract	119	Ametropia	8
Leucoma	24	Pterygium	5
Trachoma	11	Conjunctival trauma	1
Staphylomata	7	Pannus	3
Conjunctivitis	24	Symblepharon	1
Entropion	3	Xerosis	2
Spring Catarrh	2	Injury to globe	1
Glaucoma	47	Night blindness	1
Atrophy of globe	6	Old cataract cases for glasses	2
		Total	267

One hundred fifty-two operations were performed January 22, 1923, as follows:

For cataract	100	Meibomian cyst	1
Leucoma iridect	10	Dermoid cyst	1
Glaucoma "	3	Strabismus, tenotomy	1
Pannus conj. inj.	2	Tumor of scalp	1
Pannus, peritomy	2	Internal hemorrhoids	6
Pterygium	6	Fistula in ano	1
Symblepharon	1	Vesical calculus litholapaxy	2
Dacryocystitis	1		
Trachoma–scraping	4	Inguinal hernia	1
Trichiasis and Ent.	7	Hare lip	1
		Total	152

The 100 cataract cases operated were in no way selected, none were excluded but those suffering from dacryocystitis, or suppurative conjunctivitis. Many did not promise much on account of large corneal opacities, decidedly increased tension, or sluggish pupils, and in most cases there was trachoma.

SPEED OF OPERATION: No attempt is made to hurry any of the operations, neither is any time lost. There are two operating tables and two assistants who place the patients upon the operating tables. The operator cleanses the eye as well as the area surrounding it, with 1–2000 bichloride of mercury, and finishes the cleansing process by flushing the eye with the same solution. The excess is removed, the operation performed, a wet pad placed upon the eye by the operator, and the bandage is left to the assistant.

Dr. W. A. Fisher of Chicago operated in this manner upon 113 eyes January 22, 1923, thirteen of which were iridectomies for glaucoma, or for optical purposes, and one hundred for cataract, between 10:00 A.M. and 5:30 P.M. with one hour for lunch, which gave him 6½ hours operating, or 390 minutes, so that he did one operation every three and a half minutes.

RECORDS: Dr. Bradley, of Calcutta, acted as registrar, and noted down all the complications that occurred at the time of operation. Two of the patients were so obstreperous and violent on the table that they had to be chloroformed, and several others were distinctly bad patients and struggled during the operation.

COMPLICATIONS: Spoon deliveries 6; Burst capsules 9;

Vitreous loss 12; Lost lens in vitreous 1. (Eye bandaged, lens easily removed from anterior chamber third day.) Expulsion of the lens following the incision 4.

BILATERAL OPERATION: It is the rule to operate upon both eyes where each one has cataract, no matter what stage of opacity. The results are quite the same as when operating each eye separately, and the complications no greater. Twenty-five of these patients (or fifty eyes), were double operations. Good results in both eyes in twenty good results in one eye in the other five cases.

FIRST DRESSING: The eyes were dressed on the fifth day, and on that day in some cases the results were so perfect that the patients in twelve of the cases could have gone home; as a matter of fact, fifty-eight of the one hundred went home before the ninth day.

AFTER COMPLICATIONS: Capt. Cruickshank (I.M.S.), Ophthalmic Surgeon, Rawalpindi Division, examined the cases January 28th, six days after operation and found the following complications had occurred after operation:

Prolapse of iris—3 cases, i.e., 3%, and slight incarceration of the iris in the wound in 5 cases. Choroidal hemorrhage occurred in 2 cases; sepsis 2 cases; hazy cornea 2 cases; hyalitis 2 cases; gaping wound 1 case.

RESULTS: Good surgical results in 92 cases; otherwise in 8, i.e., two of which were due to choroidal hemorrhage, two to sepsis, one glaucomatous eye, which should not have been sent to the operating room and three in which there was no vision, probably due to choroidal and retinal changes. Of these, the four latter were in no way the fault of the operator, and were cases to which I have already referred, in which the patients gave a false history and so misled me in the out-patient room.

Had the tonometer been used in each case, as we did during the latter part of our work (when there was less work) and if four or five of the plus tension eyes operated upon had been excluded, Dr. Fisher would have had 96–98% of surgical successes.

STAFF: It might be of interest to give details of the staff, January 22, 1923.

In the cataract room we had two assistants for holding the

lids, one at each of the two tables, and one sister who superintended the cocainization of the patients, the operator and the registrar (Dr. Bradley) who noted down the operations and complications at the time of operation.

In the second operating room were two doctors employed in performing all operations, except cataracts and iridectomies. In the dressing room were two dressers and one hospital sister, and in the out-patient room, one doctor, so we were by no means overstaffed. In this room 39 operations were performed.

On some days there were as many as 250 operated cases to be dressed and these were done by one doctor, one sister and two dressers, of whom one removed the bandages of those requiring dressing and one followed the doctor putting on the bandages and shades after dressing.

METHOD OF OPERATING: Our routine method of operating senile cataract is the intracapsular as devised by Col. Smith, formerly of Amritsar, and the treatment is to dress the eyes of those not complaining, first on the fifth day, and on the seventh, if there are no complications, to put on a shade, and the greater number of our patients leave on the seventh, eighth and ninth day after operation.

POST-OPERATIVE INFLAMMATION: Post-operative inflammation is rare, and needlings are not required except in a few of the cases of burst capsule.

WHY IS THE INTRACAPSULAR OPERATION SELECTED: All operators, as far as I know, who are removing lenses in capsule, began their work by the capsulotomy method, and are quite familiar with the advantages and disadvantages of both methods.

My reasons for changing from the capsulotomy to the intracapsular method were because it was not necessary to wait until the cataracts were ripe, and there is less post-operative inflammation; needlings, only in some of the burst capsules, and in the end, better results were obtained.

SUMMARY: Of all the complications noted at time of operation, and during the healing process, only nine require mention: one of the two sepsis cases was probably due to a plus tension eye. The two hemorrhages of the choroid probably were from the same cause, and unavoidable. The two hazy

corneas will probably clear. The two cases of hyalitis may have some vision, and the gaping wound may have useful vision.

CONCLUSIONS: 1. Every cataract patient who has a chance of improvement of vision is operated, whether his tension is high, lids unhealthy, or pupils sluggish.

2. Emphasis should be placed upon complications occurring at the time of operation, provided such complications affect the final result. Also, complications during the healing process that affect the final result.

3. Thirty-two complications at the tme of operating one hundred eyes would seem high unless analyzed, but if only nine are serious, the percentage is not high when the material is considered, whether the intracapsular or capsulotomy method is selected.

4. Six spoon deliveries would appear too high if the capsulotomy method was being used, but if the spoon is used at once, as soon as a slight loss of vitreous has occurred, the after danger is not great. In fact, five of the six spoon deliveries were perfect at the first dressing.

5. Nine burst capsules is not high considering our patients; so many have high tension, favoring this complication.

6. Vitreous loss in twelve per cent is not high, considering our material. In fact, ten of the twelve appeared quite normal at the first dressing.

7. The lens that was lost was unavoidable, and might occur during an operation by any method. When such a complication occurs, the eye is bandaged and the lens is usually found in the anterior chamber the third day, at which time it can readily be removed.

8. Extruded lenses (four) at the time of incision: This complication should seldom occur with a good operator by any method, if the tension is normal and the patient does not squeeze the lids. This last cause can be practically eliminated if Fisher's lid hooks are used. No ill effects followed any of the four.

9. Post-operative inflammation seldom occurs if the lens is removed in capsule, and post-operative inflammation was not the cause of any losses in this series.

10. Sepsis was the cause of two eyes being lost, one of

which was a high tension eye with vitreous loss; the other uncomplicated at the time of operation.

11. Hemorrhage of the choroid caused two losses but were uncomplicated at the time of operation.

12. Hyalitis occurred in two cases, one a spoon delivery, the other a vitreous loss.

13. The gaping wound was a vitreous loss.

14. Iris prolapse in three cases would be considered low by any method.

15. Iris incarcerations in five cases is also low by any method.

A CASE OF RING SARCOMA OF THE IRIS.

By Dr. ABRAM B. BRUNER, Cleveland, Ohio.

(*With two illustrations on Text-Plate XII.*)

THE most frequent malignant growth of the iris is sarcoma. Even this clinical entity, however, is so infrequently seen, that each case seems worth reporting. The case reported below also has several interesting and distinctive features.

G. W. S., a man aged 43, was first seen December 10, 1921. He stated that about five months before he had first noticed his vision getting slightly hazy in the left eye. There was no history of previous inflammation or of injury. Until a few days ago there had been no pain, but since this time there has been irregular dull pain in the eye. The vision has gotten progressively worse since the onset of the present trouble. He had always noticed a little colored spot on the inner half of the iris of this eye and lately this spot has gotten larger. Several weeks ago he was examined by an oculist who advised a blood Wassermann as an aid to diagnosis. The Wassermann test showed four plus. Since that time the patient has had active anti-luetic treatment but the local condition has gotten steadily worse. General health is excellent. Occupation, bricklayer.

Examination shows vision in the right eye $\frac{5}{4}$, in the left eye $\frac{5}{15}$. The right eye shows nothing abnormal externally or ophthalmoscopically. The left eye shows a slight conjunctival hyperæmia with a moderate ciliary injection. The cornea is steamy and hazy in appearance, except for several relatively clear areas. The iris responds to light except downward and inward where it is apparently adherent to the anterior capsule of the lens. The aqueous is slightly cloudy. The anterior chamber is markedly deeper than normal and the tension is stony hard.

On the anterior surface of the iris, covering the entire extent between the positions of about seven to nine o'clock, is an area of brownish pigmentation with apparent thicken-

ILLUSTRATING DR. ABRAM B. BRUNER'S ARTICLE ON "A CASE OF RING SARCOMA OF THE IRIS."

FIG. 1. Low power microphotograph showing the location of the main part of the tumor at the ciliary portion of the iris.

FIG. 2. Low power microphotograph showing the extension of the growth from the iris into the ciliary body and ligamentum pectinatum.

ing of the iris tissue. This brownish mass is about the size of a split pea, being thickest at the root of the iris but extending to and overlapping the pupillary margin. From the anterior surface of the tumor a number of light brown tentacles protrude forward into the anterior chamber and laterally into the pupillary area.

Ophthalmoscopic examination of the left eye shows cloudiness of the cornea and many fine opacities of the vitreous. The disk is still a fair pink in color but shows total cupping. The retina and choroid show no noticeable pathology. With a + 20 diopter lens the iris, at the site of the pigmented mass, has a distinct reddish-brown color. The iris tissue is apparently thickened and projecting forward. No thickening could be made out behind the iris.

Transillumination of the globe was negative. The tension as measured with a Schiotz tonometer was 50*mmg*. There was a marked contraction of the nasal visual field.

A tentative diagnosis was made of new growth of the iris and the patient was sent to the hospital. After several days treatment and observation in the hospital the tension still remained very high, the vision continued to get worse, the local discomfort increased and the eye was enucleated.

Pathological Report. The cornea is normal. The anterior chamber is much deeper than normal but the filtration angle is nowhere blocked by the iris root. The ciliary body and its processes are atrophic. The choroid is much compressed but the choroidal vessels much congested. The retina in the sections is detached but appears normal. The optic nerve shows a marked cupping of the nerve head.

Sections taken through the pigmented mass on the iris show a thickening at the root of the iris due to a cellular growth arising apparently from the anterior boundary layer. The cells of this growth are similar to those of a small round cell sarcoma. At the extreme root of the iris the new growth involves nearly the entire thickness of the structure but has produced almost no abnormal thickening. The new growth has extended mesially over the anterior surface of the iris to the pupillary margin, the growth varying in thickness but being most prominent near the tip of the iris. Laterally it has very slightly invaded the anterior portion of the ciliary body and is also extending forward over the angle of the chamber and advancing for a short distance along the posterior surface of the cornea. Sections through the ciliary body and angle

of the anterior chamber opposite to the new growth in the iris show that the ligamentum pectinatum has been infiltrated all around. Some of the tissue spaces in the sclera extending from the filtration angle are seen to be filled with tumor cells. The pigment present in the tumor varies in different places but on the whole is small in amount. The greatest pigmentation is where the tumor has actually invaded the iris stroma while along the anterior surface and in the ciliary body and ligamentum pectinatum there is practically no pigmentation. It is very likely that the pigment present is that of the iris stroma itself.

Comment. Several sections were sent to Dr. Frederick H. Verhoeff of Boston, who very kindly read and corrected this manuscript and drew my attention to a number of interesting things about this tumor. I shall state them briefly in my own words but wish to make acknowledgment here for his valued assistance in the study of this case.

The tumor is without doubt a sarcoma of the iris, probably arising from the so-called anterior endothelium, and is similar to a melanoma of the iris which has become malignant. The reason for its slight pigmentation is perhaps explained by the small amount of pigment in the stroma of this iris. The new growth can be traced from the iris into the ligamentum pectinatum, this latter structure being infiltrated all around, thus blocking the drainage from the anterior chamber and producing the glaucoma. Another interesting fact is that the glaucoma is comparable to a buphthalmos, as the anterior chamber is much deeper than normal and there is no peripheral anterior synechia. This tumor, according to the definition of Li,[1] may be classified as a ring sarcoma of the iris. An especially noteworthy feature of the growth is that it so early assumed a diffuse character.

Finally, it should be noted that there is a general misconception regarding the so-called endothelium in the anterior chamber. As the embryologists point out, the layer of cells on the back of the cornea is not endothelium but mesenchymal epithelium. Over the anterior surface of the iris the cells of

[1] T. M. Li. "Primary Ring Sarcoma of the Iris." *American Journal of Ophthalmology*, July, 1923.

the anterior boundary layer become very much flattened and should also be regarded as mesenchymal epithelium. They are the same as the stroma cells except that in their surface position they have taken on a different character and arrangement. A tumor arising from this anterior boundary layer would therefore be a sarcoma, not an endothelioma.

TRACHOMA AMONG THE BLACKFEET INDIANS.

By L. WEBSTER FOX, M. D., Philadelphia.

THE Federal Government has done a very commendable thing in setting aside that portion of the State of Montana known as "Glacier National Park" as a national playground, and those of us fortunate enough to visit it can experience a feeling of pride at our government's thought and consideration of the future, but should we examine carefully into all the features it has to offer, we experience a feeling of chagrin at the lack of thought and consideration shown the Government's wards, the Blackfeet Indians, in this section of the country.

It has been my privilege over a number of years through affiliation with the government school at Carlisle, and also by reason of numerous inspection tours through the reservation and camps in the great Northwest and Alaska, to familiarize myself with the ocular diseases prevalent among the tribes under civilization and those free from the same degrading influences, and to study their behavior under treatment. It was, therefore, with no little enthusiasm that I accepted an invitation to visit the Blackfeet Indian Reservation at Downing, Montana, and to review the estimable work of Doctor C. E. Yates, at Hart Butte, and of Doctor W. C. Barton, then also at the reservation but now in Nevada continuing the same line of work. The consideration shown the surgeons by the government is no less generous than that shown the Indians, and their continuation in the field is a monument to their idealism. It is remarkable that such good men could be prevailed upon to accept this work under such scanty remuneration.

The Blackfeet Indian Reservation is situated in the northern part of Montana immediately south of Alberta, Canada, and extends sixty miles south of the Canadian line. The western boundary line of the Reservation was originally the continental divide of the Rocky Mountains from which line it extended to an average of about sixty miles east. Its length from north to south was about the same distance.

This reservation has an average altitude of about five thousand feet and as a consequence of its northern location and high altitude, the climatic conditions are, particularly during the winter, rather severe. It has been considered essentially a grazing country, with very little or none of the ordinary agricultural possibilities. On account of the frosts that occur so late in the spring, early in the fall, and at any time during the summer, it has been presumed that the agricultural products will not grow to maturity.

During the period known as the "Plains Days" these Indians were considered very successful hunters and trappers, and are even yet a very high type among their fellow tribesmen and show industrious qualities when properly guided and encouraged. With the settlement of the Northwest they became restricted to certain areas. They were fortunate enough to be assigned areas that subsequently were purchased from them, such as the Glacier National Park, so that in the period covered by 1917, 1918, 1919, they enjoyed considerable prosperity, one of the evidences of which was the amount of Liberty Bonds to which they subscribed.

Following 1918, drought conditions prevailed and continued through 1920 rendering the tribes bankrupt and entailing in 1921 rationing and gratuity support of over two thousand Indians. Their crops were failures and their finances exhausted, and like their white agricultural neighbors, their credit was zero.

However, failure need never be absolute, and out of this ruin was conceived the idea of a five year program of coöperative farming by Superintendent Campbell. A central organization was effected with branch organizations in each community, thirty chapters in all eventually, all under the control of the more intelligent members of each tribe, guided and directed by the supervisors of the district. The work of

the second year of this organization resulted in cancelling all flour contracts for the school and agency, and for the first time in the history of the Blackfeet Indians, as far as we know, they have raised their own flour. This is the more remarkable in view of the fact that the grain fields were only from two to five acres to each Indian, seventy-two small fields of wheat in all.

Progress was proportionate in other lines of agricultural activity and all that remained on their farms now have enough to sustain themselves, and some a surplus to sell. The supervisors and Superintendent Campbell are to be congratulated upon having uncovered this latent energy and industry among these Indians. This activity was not restricted to the men, but a Women's Auxiliary was organized to supplement the activities of the men, and to utilize the five months of practically idleness enforced by the climate.

This sidelight on conditions among these Indians is interesting and doubly so if we are to accept the statement of Dr. E. E. Higley, of Chicago, of the Methodist Episcopal Church Missions, that the census among the Indians shows an increase rather than a decrease as is popularly supposed.

But, a personal contact with the physicians of this reservation and personal observations of the Indians themselves, reveals deplorable conditions of which we should be heartily ashamed and deeply chagrined by their existence.

In the settlement north of Two-Medicine River, these physicians examined 517 persons and found that 154, or thirty per cent, had trachoma! We would need to have a very big exclusively eye service to furnish that many cases. There were also 14 persons blind in one eye, 2 blind in both eyes, and 3 practically blind. The causes were not all the same.

In the settlement south of Two-Medicine River, they examined 441 persons, of which 105, or 23 per cent, showed trachoma. Here there were also 15 blind in one eye, 6 blind in both eyes, 6 practically blind.

In the Holy Family Mission School, examined by Dr. Ross, 38 cases, or 40 per cent, were observed in 95 examined, and in the Cutbank Boarding School, also examined by Dr. Ross, 54, or 47 per cent, were found out of 115 examined. These latter institutions were more or less permanent winter schools for children—the heavy snows and the rigors of the climate

preventing the majority of the children from returning to their homes. They were snowbound most of the term.

Taking the cases and the individuals as they come, we find 351 cases of trachoma existing among 1168 people or a percentage of 30.05—and the tribes are increasing in number! Think, for a moment, of the consternation that would ensue, should the steerage accommodations of the *Leviathan*, for instance, show up to be harboring 351 cases of trachoma. With the steerage passengers, some go back home—but our Indians stay with us.

In the very populous districts in the East we have repeatedly pointed, with pardonable pride, to what amounts to almost complete eradication of trachoma as a pandemic disease, yet a few miles out and we encounter centers of the affliction, sufficient to affect the whole country in a short t me should communications be established with othe points.

While there *appears* to be some difference of opinion as to the proper treatment of the disease among ophthalmic surgeons, they are agreed upon one thing, namely, that whatever means is employed it should be employed vigorously and in a most intensive manner. Neither Christian Science nor Osteopathy have ever influenced this disease.

In the case of medicaments used in the eye, the application of anything once a day is of no value. Years ago when the use of jequirity was in vogue and must have been observed to have been of some value, it utilized this factor of intensity.

The surgical treatment, especially "grattage," which I have used so frequently with good results, emphasizes the value of approaching this disease in a radical frame of mind. The best treatment of all for the pronounced and resistant cases is resection of the tarsal cartilage.

These methods and their application are well known to us in the larger, and in many of the smaller, centers—hence the low incidence of trachoma. The first step in the prevention of any disease is the eradication of the center from which it comes. The second step, that of prevention of new cases, is best guided by imitating the conditions that obtain in the communities that have not the disease.

It is not the purpose of this paper to dilate upon the treatment and prevention of trachoma altogether, but it is also the

purpose to call attention to the frank negligence of the government in failing to give to these, our own people, what it hastens to give to the foreign born that come to our shores. It is hoped that this message will be carried by my hearers to those influences that may help to furnish the proper aid for the relief of this deplorable situation.

When this comment was first presented it aroused a counter criticism that no practical suggestions as to the clinical signs, differential diagnosis, treatment or prevention accompanied it, for the guidance of those interested in bettering the conditions herein described. Consequently, a few observations on the medical and surgical aspects of the condition are herein incorporated.

Many of the writers on this subject prefer the term Granular Conjunctivitis when considering the condition from a clinical standpoint, since all pronounced cases of conjunctivitis with exuberant granulations produce the same devastating effects on the cornea and call for almost similar forms of treatment. The terms, Trachoma, Egyptian Ophthalmia, Military Ophthalmia, etc., refer to other features of the disease. Perhaps the least serious form of granular conjunctivitis is the type that occasionally follows the prolonged use of eserin.

The laboratory work has demonstrated the infectious character of the affection, thus corroborating the clinical observations regarding its contagious nature. Except for the purpose of scientific discussion, the finer points of the pathology are of no great moment. In large groups of people, the presence of any one type is likely to be the beginning of a large epidemic of the classic form of the disease, as the many factors necessary to the production of the disease are constant. It requires more than just the presence of the isolated germ to produce the disease.

The Indians to whom we have just referred, are living under the best conditions for the production of the disease. Personal hygiene exists at the irreducible minimum with them, and seems not to be appreciated to the fullest extent by those whose responsibility is to care for them. Not possessing the natural immunity to the disease of the North American negro, but rather showing a predisposition to it, they become easy prey to the many forms of conjunctivitis that may elect

to infect them. No attention is given to the catarrhal conditions of the upper respiratory tract and minor conditions are permitted to become chronic.

The handling of these cases requires intensive and not perfunctory treatment, but the policy of the Service seems to be, to give attention only to the more major affections. Persisted in, this policy will serve to render most of the tribes blind, semi-blind, and, industrially, invalids.

We would advise the ordinary treatment recommended in text-books on ophthalmology for all cases of conjunctivitis among these people, but would urge its persistent application, with a check up of results. And we would further advise the caring for all nasal conditions in the same manner. There is sufficient anatomical connection between the nasal passages and the eye to justify considering both in the event of an inflammation of either. It is not sufficient to diagnose and prescribe for these cases. The early stages of these inflammations respond to appropriate treatment promptly. The treatment should be applied by medical attendants and not left to chance. This doubtless entails more medical officers, but why not? It is money saved. A discharging eye or nose is a menace to any community. The whole catalogue of pathogenic bacteria may be demonstrated in any of these discharges.

NOTE—Since writing the above paper Mr. Amos H. Burke, Commissioner of the Department of the Interior, Indian Affairs, Washington, D. C., made it possible for Dr. C. E. Yates, of the Blackfeet Indian Reservation, to come on to Philadelphia for an intensive course for the treatment of trachoma among the Indians. Dr. Yates has been under my care for the past two months. He has returned to the Reservation, where he expects to carry out the treatment and operation as demonstrated by myself.

AN ANALYSIS OF THE COMPENSATION PROBLEM AS IT RELATES TO OCULAR INJURY.

By Dr. ALBERT C. SNELL, Rochester, N. Y.

(With three figures in the text.)

(Concluded from the January Number.)

Measurement of the Competitive Element

(Factor C, in formula $F \times C = E$)

In making the analysis of full earning ability the ability to compete was considered as an essential factor and it was pointed out that this element in one's ability to earn could not be entirely omitted from the consideration of our problem. In attempting to determine the mathematical value of the competitive factor we wish to point out the following facts:

I. The competitive element has no independent value but is entirely dependent on function and intelligence for its economic value; therefore this value is always relative to these functions, and any conceivable damage to it is entirely dependent on the status of functional ability.

II. It is not a very important factor.

III. It does not lend itself to accurate mathematical measurement.

IV. It does not become an influential factor in the equation until there is serious functional disturbance.

V. Compensation statutes have incorporated this factor into the fixed rates which have been established for definite ocular injuries.

The first point has been discussed in this paper in the consideration of the subject of visual function. In regard to the second point may we point out that those who would assign

to this factor some value even for minor ocular injuries give it a 10th or *n*th root value (see Magnus and Holt) which is so trivial in its influence on the product that it has no real or practical value in determining the loss to earning ability. Even such a trivial value is theoretical and sophistical. In regard to the third point, any attempt to give this factor a mathematical status is very much involved and complicated because its status does not depend on any fixed quantity or quality. It varies greatly with different individuals, with different kinds of employment, with the social condition of the employee, and it also depends very largely on the mental attitude of some prospective employer. To assume that this factor of the competitive ability depends primarily on the status of ocular function and then assign to it the same primary coefficient as that for visual function, is entirely empirical and also generally misleading as this gives to it a relative value much out of proportion to its importance. Although Magnus builds up a very complicated formula for the mathematical determination of the value of this factor, he states, "An exact calculation of such a changeable quantity so dependent upon the individual cannot be made."[1] In regard to the next point he also states, "While the ability to compete is comparatively very little impaired through minor ocular injuries, it is very much so through the ***loss of one eye.***" The italics are mine but please note that only when there is the ***loss of one eye*** is the competitive factor much impaired. We wish also to point out here that before vision falls to that degree at which it is actually a total loss—that is, before it falls to the point at which the competitive factor becomes an influence—it is regarded by all compensation statutes as a total economic loss. Many of the statutes definitely state that when visual acuity falls to $\frac{1}{10}$ (Snellen expression, $\frac{20}{200}$) it shall be considered as a total loss. A loss of 80 per cent. of visual acuity is regarded by the New York State statute as a total loss of use. Thus we see that when visual acuity sustains that degree of impairment at which the competitive factor would begin to have some influence on earning ability the statutes fix the disability as total. Consequently the use of this factor can have

[1] Magnus, *Visual Economics*, p. 27.

no influence on the product; its coefficient remains a whole number until industrial blindness is reached. In regard to the fifth point we have just shown above that the compensation laws have incorporated the competitive element into the statutes and in addition, in fixing the rates for total loss of vision to one eye or to both, the statutes have invariably embodied the competitive factor into these rates and schedules. Thus we find that the value of this factor has been considered and is employed in making up such rates and schedules; therefore, it should not be used a second time in the computation of ocular disability, otherwise the same factor will be employed twice in solving the same problem. This phase of the subject will be further developed later.

We conclude in regard to the measurement of factor C, the competitive ability, that its coefficient remains (1) until visual acuity falls to industrial blindness, and that when vision falls below industrial blindness it is not necessary to consider its value or coefficient as this is of no practical importance since its use would not influence the total product. Therefore in computing the visual disability for one eye, factor C, competitive ability, may be omitted entirely, since, when the coefficient of any quantity is always 1 it does not modify or change the ultimate product by its use. Any number multiplied by one is unchanged.

The discussion and the computations made thus far relate only to the impairment of one eye. This has been done so that the method may be made applicable to existing compensation statutes. Nearly all compensation laws have established rates on the basis of loss to *one eye*. Many statutes also give a different schedule of rates for the loss of both eyes and this is a somewhat different problem. When there has occurred the total loss of vision in one eye and serious damage to its fellow, earning ability is impaired to a greater proportionate degree than when only one eye is damaged, and the percentage of impairment of earning ability is more than the sum of the damage of each. In such cases factor C, the competitive element, should be used and its coefficient may be regarded as the same as that for function, factor F. And also, when the compensation statute permits, the disability should be computed on the basis of total disability. Therefore, when there

has been a total loss of one eye and partial impairment of the other, the disability rate should be computed by the formula $E = F \times C$ and the coefficient of C should be the same as that for F. The following table will show the proper disability rate for the second eye on the basis of total disability. The coefficient of F is of course the product of the coefficients of P and A and M.

TABLE III.—DISABILITY RATING WHEN ONE EYE IS LOST AND THE OTHER SERIOUSLY IMPAIRED.

Coefficients of F & C	*Per Cent. of Efficiency*	*Per Cent. of Total Disability*
.90F × .90C	81	19
.80F × .80C	64	36
.70F × .70C	49	51
.60F × .60C	36	64
.50F × .50C	25	75
.40F × .40C	16	84
.30F × .30C	9	91
.20F × .20C	4	96
.10F × .10C	1	99

This rate should be used only when the disability to both eyes is the result of the same accident or the same employment. It would be manifestly unfair to use this table of increased rates in computing disability for those who previously had only one eye.[1]

V. THE LEGAL CONCEPT OF COMPENSATION LAWS AND THE RELATION OF SOME PROPOSED METHODS TO THESE LAWS.

In order to solve any definite compensation problem, either we must employ some method of determining disability which

[1] Under the New York State Workmen's Law, see Ed. 1922, p. 50, Sec. 8, when an employee who has only one eye, the other being lost by previous accident or disease, sustains a serious impairment to the previously good eye, the disability is classed as a "permanent total disability after permanent partial disability," and the statute provides that "he (the disabled employee) shall be paid, in addition to the compensation for permanent partial disability provided" in the statute an amount equal to that for permanent total disability; which additional sum is paid from a "special fund," created for the purpose.

is in harmony with the terms and principles of the existing statutes, or we must change the statutes to harmonize with the chosen method. Moreover, both statutes and method must be based on sound economic principles. Should a study of the statutes show that they are not based on sound economic principles it would most certainly be wise to change the statutes; but if the statutes are found to conform to scientific economic principles, obviously it is better to choose some method which is in harmony with the statutes. In the earlier part of this paper we have discussed the fundamental principles of visual economics; now we wish to find out whether or not existing statutes are based on these principles; we wish also to find out whether statutes and method are in harmony. Therefore in the solution of this phase of our problem two steps are necessary. The first step is to understand the legal concept of the statutes, that is, their nature and scope. The second step is to study the various methods proposed to learn whether or not they may be employed in a way which is in harmony with existing statutes and in conformity with the principles of visual economics.

By nature of the legal concept we mean the elements which have entered into the making of the statutes. A reading of the compensation statutes reveals a remarkable uniformity both in language and in structure. The later statutes have copied the best ideas of the earlier ones and all have been constantly revised. Awards, interpretations, and decisions have had to stand the test of all the higher Courts, so that now it may be said that these laws embody the accumulated knowledge of legislators, judges, economists, physicians, and workingmen. Thus they represent all points of view and embody the composite ideas of all interested parties. That they are based on sound economic principles is revealed by the following facts:

I. Nearly all compensation statutes base awards on a loss to earning ability.

II. Most of the statutes recognize that the earning ability is synonymous with visual earning ability, since the total loss of vision is considered as a total incapacity for work, or a total disability.

III. Most of the statutes recognize that a total earning incapacity is reached before a workingman's vision is reduced to

total blindness. This concept necessarily includes the idea of impairment to both functional ability and competitive ability.

In reference to our particular problem there are two features in the scope of the law which must be understood. The first one is that both the competitive factor and the age factor are embodied in the statutes as intrinsic and inseparable parts of the law. The second one is that the statutes fix the monetary basis for computing earning ability and loss thereto.

That the competitive factor is embodied in the statutes is shown from the fact that they all recognize as industrial blindness, a degree of vision which is far from actual or total blindness. For example, the statutes of Connecticut, Indiana, Maine, Pennsylvania, Tennessee, Vermont, and possibly others, state that $\frac{1}{10}$ (Snellen expression $\frac{2}{200}$) or less of normal vision shall be considered as a total disability; and the New York State Law states that compensation for the loss of "eighty per-centum or more of vision of an eye shall be the same as the loss of the eye."

With regard to age, we find that the statutes also consider that the age-experience factor is reflected in the pay envelope, also many of the statutes have established special rates which make provision for a proper adjustment of the age factor when the young are injured. Therefore this does not enter into the problem of computing visual disability.

The monetary basis for computing earning ability and loss thereto is defined in the law. All of our statutes stipulate that earning ability is most equitably determined from the actual wages which the workingman has been able to get and has actually received. Thus we find that in most of the statutes the earning ability and loss thereto is specifically fixed by statute in accordance with wages actually earned, the compensation for loss usually being some percentage of weekly wages. The total amount of the compensation is also fixed for the various degrees or kinds of incapacity and is usually specified as a definite number of weeks' wages. For example, nearly all statutes fix the total number of weeks' compensation and the rate for the loss of use of one eye, and they also fix the total number of weeks' compensation and the rate for the loss of both eyes, or for the loss of one leg, or of both legs, or of one, or of both arms, etc. In New York State the rate for the loss of an eye is fixed

at 66⅔ per cent. of the average wages during the preceding year for 128 weeks. For permanent partial disability the rates are also fixed by all statutes, usually being an amount in terms of weeks' wages relative to or proportionate to that designated in the schedule for a total loss of that member, part, or organ. It is important to observe here that our statutes do not award compensation for the entire disability period. The disability rates are almost invariably limited to some proportion of wages for a definite number of weeks or a fixed total even for total blindness.[1] For the loss of one eye most laws have fixed 100 weeks, the maximum being that of Wisconsin, 140 weeks. For the loss of both eyes, the number of weeks definitely fixed is from 240 to 520. The disability rates are not for the duration of the disability, that is, they are not extended continuously for life or for the remaining years of the expectant earning period. Compensation awards are not in the nature of continued pensions. This point is emphasized here because two of our most scientific methods of determining disability conflict with this feature of the statutes. This will be shown later.

From these facts the function of the medical examiner is clear. It is not his business to establish the rate of compensation nor the amount which must be awarded for the total or for the partial loss of use of an eye. It is his business first to establish the fact of the disability, and second to determine the nature of the disability; that is, whether there has been no loss, total loss, or partial loss; and when there has been a permanent partial loss or loss of use of a member it is his duty to determine the "proportionate loss or loss of use" of such member, or the proportionate amount of the ocular disability, which means that primarily he must determine the degree of the functional disability.

With these facts in mind let us study some of the various methods for computing compensation now before the public. The methods which have been offered for our consideration and which have attracted the more universal attention are those presented by Magnus and Wurdemann, Holt, the Com-

[1] The statutes of California, Colorado, Nebraska, New York, Utah, and West Virginia are exceptions. In these states blindness in both eyes is a total incapacity, and for this condition the compensation is for life.

mittee of the A.M.A., Smith,[1] Allport,[2] Chapman,[3] and Sharp.[4] These methods will be considered briefly in order to determine whether or not they conform with the established principles of visual economics, and whether or not they harmonize with the statutes.

The work by Magnus which was edited and translated by Wurdemann contains an exhaustive presentation of the entire subject of visual economics. The fundamental principles established by this work have received an almost universal acceptance and approval. This system lays down the premise that earning ability is synonymous with the visual earning ability, that visual function is "the essential factor in the full earning ability, damage to which is synonymous with damage to the total," and that the three essential elements of vision "are to be regarded as factors of a product and multiplied." Therefore this method conforms with sound economics. But from these basic principles Magnus builds up a very complicated mathematical formula to represent the full earning ability, which is so involved with complex algebraic expressions that only a few have made practical use of the method. It has been shown that in the practical application of this formula to our compensation laws, the most complicated part of it—that which relates to the competitive element in the earning ability—should be left out of consideration, at least in computing the disability for one eye, in view of the fact that this factor has been usually considered and employed by the compensation statutes in making up the schedules of rates. When this factor is employed once it should not be used a second time in computing the same problem.

There is a more fundamental point of difference in the application of this method which is found in the fact that the award for damages is based on the determination of *full* earning ability and any loss thereto. The impairment of earning ability is thus based on a proportionate loss of *full* disability; which means that the disability is for the entire period of the

[1] Smith, E. T. "The Estimation of Compensation," *Trans. Am. Ophth. Society*, 1921.

[2] Allport, F., Jr., *Jour. Am. Med. Assn.*, 1920, lxxiv., No. 3, 166.

[3] Chapman, N. A., *Wis. Med. Jour.*, Ju., 1918, xvii., 54.

[4] Sharp, W. N., *Am. Jour. Ophth.*, Ju., 1920.

remaining earning years. A permanent total or a permanent partial disability is necessarily a disability for the remainder of the earning period of life and is properly so employed, but our compensation laws did not and have not employed this epoch—the expectant earning period—as the basis for computing their rates. They have invariably taken, as we have pointed out, a definite limited number of weeks' wages or some percentage thereof, as the basis for the disability-period-rate which is as a rule only a small fractional part of the disability-time-period. Thus it must be apparent that since the basis of computing compensation is established on a different disability rate from that of the Magnus method, the solution of the problem must be approached from a different point of view. It is also apparent that the tables of Magnus which determine the impairment of earning ability for a disability-life-span cannot be used to compute compensation according to the fixed rates of our laws which limit the total amount to a definite and limited number of weeks. This point is more clearly shown by giving some concrete examples. In the first place note that nearly all statutes fix the disability rate for the loss of one eye; therefore when one eye is totally lost the compensation for a total loss of this eye necessarily must be the total amount, or 100 per cent. of the fixed amount. Now note that the percentage rate according to the Magnus method for the total loss of one eye is 15 to 22 per cent. Compensation computed on a 22 per cent. basis cannot be the same as that computed on a 100 per cent. basis. For example, when a workingman, earning $30.00 per week, loses one eye, the Magnus table shows that there is a 15.6 to a 22 per cent. impairment of earning ability. On a weekly basis this gives a compensation of $4.68 to $6.60, which for 128 weeks is $599.04 to $844.80. For the total loss of one eye the New York State statute fixes the compensation as 66⅔ per cent. of wages for 128 weeks. Computing the compensation for a man earning $30.00 per week we would find that 66⅔ per cent. of $30.00 is $20.00, and 128 multiplied by $20.00 is $2,560.00, the total amount of compensation which must be awarded in New York State in this case. Compare with this $844.80, the maximum under the Magnus rate. From this it should not be interpreted that this compensation law, or compensation laws in general, make

a more generous award than does the method of Magnus, for quite the contrary is the fact. If the Magnus rate were computed for a life-disability period the amount of award would usually be greater than that determined from the compensation statutory rates.

The adverse criticism of the Holt method in relation to compensation laws is mainly twofold. 1st.—Dr. Holt assumes that the loss of one eye is 18 per cent. of the total bodily function, and that the loss of both eyes is 36 per cent. of total bodily function; and 2d—by employing the functional and the competitive factors in the relation of multiplicand and multiplier, the coefficient of the second being determined primarily to be the same as that for function, he determines the total loss of earning ability to be a fraction. For example, the fraction resulting from the loss of one eye is 32 to 54 per cent. As was shown above in the application of the Magnus method, any sort of table that considers the total rate for the loss of an eye as 54 per cent. when the statute fixes the rate for this loss as 100 per cent., cannot be employed to solve this specific problem. Therefore the rates shown in the Holt tables cannot be used to compute this or other degrees of ocular disability or compensation in conformity with the fixed rates of our compensation laws. Compensation laws require a determination of the proportionate loss of use of visual function alone, the competitive element being left out since it is included in the schedule. Thus in these two important respects this method is not in harmony with our compensation laws. Furthermore, the relation of earning ability to ocular disability is established by statute, therefore this is not a practical part of the compensation problem. For example, the disability resulting from the loss of one eye is fixed in New York State as $66\frac{2}{3}$ per cent. of 128 weeks' wages and not as 18 per cent. of total bodily disability or as 54 per cent. of earning ability.

In order to demonstrate that the employment of the Holt table or method will give erroneous results we present the following concrete examples: To compute the compensation for a man earning $25.00 per week who has lost his left eye, by the "natural science" method of Dr. Holt, we shall find that the total loss of one eye as shown by his eye table is a loss of 32.76 per cent. of the earning ability, therefore on a weekly basis the

loss must be .3276 of $25.00 which is $8.19[1] and this multiplied by 128 is $1,048.32, the total compensation by the Holt method for the total loss of one eye. The New York State law states that for the loss of an eye the compensation shall be 66⅔ per-centum of the weekly wage for 128 weeks, therefore we must compute as follows: 66⅔ per cent. of $25.00 is $16.66, and $16.66 multiplied by 128 is $2,134.80. Thus by the Holt method compensation for the loss of one eye for a man earning $25.00 per week is $1,048.32, but according to the New York State statute it must be $2,134.80. The discrepancy is apparent and demonstrates that however excellent in principle the Holt method may be it is not applicable to the New York statute. Neither is it applicable to any other statute where a fixed rate is established by the statute. For example, take Maine where the loss of an eye is fixed as ⅔ of wages for 100 weeks. Again taking a $25.00 weekly wage; ⅔ of this is $15.00 and $15.00 multiplied by 100 = $1,500.00, the compensation stipulated in Maine for the loss of one eye for a man earning $25.00 per week. By the "natural science" method of Holt the "logical weekly compensation" is $8.19; this multiplied by 100 = $819.00; but the Maine law states that it shall be $1,500.00. Thus it is apparent that this method is not applicable when there are fixed schedules of rates.

Let us next consider the methods advocated by the committee of the A.M.A. Ophthalmic Section, as shown by its printed reports. This committee has been continued and is at present conducting an investigation and study of the many complex elements which enter into the compensation problem, therefore these reports should be considered as preliminary until a final report is submitted.

The chairman of this committee, Dr. Black, after corresponding with a considerable number of Ophthalmologists throughout the United States, found that there was a concensus of opinion that $\frac{20}{120}$ is regarded as the approximate point of industrial blindness. This is in practical conformity with many compensation statutes. However, the rates of compensation as suggested by the majority 1922 report of this committee are not in harmony with sound economic principles,

[1] Computation made by E. E. Holt, Jr., *Trans. Am. Ophth. Society*, vol. xix, p. 388.

neither does this report conform with the specific provisions of many compensation statutes; for example the New York State statute.

This committee in its 1923 report accepts as one of the fundamental basic principles for computing compensation, the concept that the efficiency value of essential functionating elements of vision have the relationship to one another as do the factors of a product. The other methods may be considered together as they do not greatly differ in principle or in their practical application. All of these methods as well as those proposed by the 1922 reports of the A.M.A. committee base the value of visual acuity on the Snellen notation used in arithmetical progression which we have shown is a departure from previously approved and accepted procedure.

T. Smith stresses the importance of the age factor and the nature of the employment, the rate of compensation being based primarily on the percentage of visual acuity, and this factor being modified by the age and occupation of the workingman. His percentage of visual acuity is based on the size of the visual angle taking the 50 minute angle as 0 vision and making slight modifications which his experience has indicated. In regard to this method of procedure we may point out that in view of the fact that to a very large extent the actual wages earned accurately reflect the nature of the occupation as well as the age-experience factor, such a complicated table and chart are unnecessary. At any rate the statutes have regarded actual wages earned as the best basis from which earning ability should be computed without regard to the age factor, and further a minimum rate is generally fixed so that the young shall not be awarded an inadequate compensation.

Allport, Sharp, Chapman, and others have suggested tables of percentage of vision considering the factor of central visual acuity only. These percentages are based on the size of the visual angle, and the 55 minute angle ($\frac{20}{220}$) is usually taken as the lowest limit of useful vision. The tables of percentage for visual acuity proposed by these methods differ very little and are in approximate conformity with the opinion of the great majority of ophthalmologists throughout the United States for the measure of this factor. But all methods which disregard field and muscle function are incomplete and not in

harmony with many compensation laws, neither are these methods in accord with economic fact since they omit these factors which are essential to vision, and both may suffer damage from industrial disease or accident.

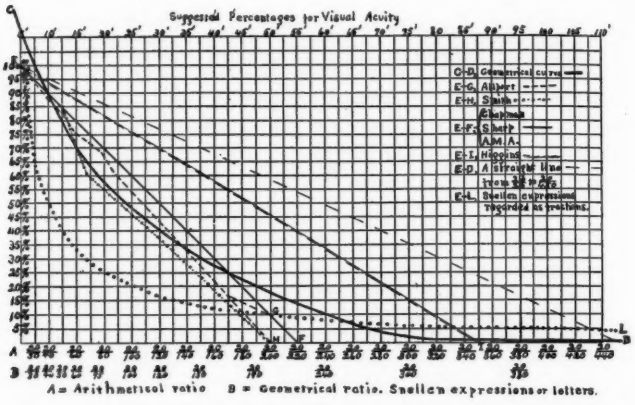

FIG. 3. Showing size of the visual angles and the corresponding percentages of visual acuity for one eye as suggested by various authors; and also illustrating that the line of vision from $\frac{20}{10}$ to $\frac{20}{200}$ cannot be a straight line.

The above graph is interesting and instructive since it clearly shows that authoritative opinions in regard to the determined value of the factor of visual acuity and its impairment are in approximate agreement. In the graph the Snellen expression and the size of the visual angle are represented by the ordinates and the percentage of visual acuity is found by consulting the abscissas. It should be noted that although the A.M.A. majority report has used the basis as indicated in the graph to determine the percentage of visual acuity, the corresponding compensation award is, in general, 50 per cent. less than the indicated percentage of visual acuity.

We have discussed the fundamental principles which are requisite to a proper understanding and correct solution of the compensation problem and have shown in what respect some of the established or proposed methods violate these principles, and are thus either inconsistent, incomplete, and

fundamentally wrong, or else not in harmony with existing compensation laws, or both. A method should now be suggested which does not violate fundamental economic principles and which avoids the objections which have been disclosed. We believe that without violating the accepted fundamental principles of visual economics and without violating the laws of mathematics the method herein suggested will determine visual disability in a manner in harmony with present compensation laws.

SUMMARY.

The compensation problem as it relates to damage to vision presents five distinct phases: the basis on which compensation rests; the mathematical relationship of the essential elements of any complex form of operating energy; the economic relationship of vision to total bodily function; the numerical measurement of the essential elements of vision, and their relationship to earning ability; and, finally, an understanding of the scope of present compensation laws—that is the way in which the proposed methods of computing compensation conflict or harmonize with these laws and with accepted principles of visual economics.

I. The only economic basis on which compensation may be equitably computed is for that loss which results in a decrease in *earning ability*.

II. The essential co-ordinating elements of any form of operating energy stand in that relation to one another as do the factors of a product, and not as the elements of the sum. This law or principle is applicable to the consideration of the mathematical relation of the elements which compose such complex forms of energy, as earning ability, general bodily function, and the visual function. Earning ability is composed of three essential co-ordinating elements, functional ability, competitive ability, and technical ability. Being essential elements each has an integral numerical value when undamaged, and 0 value when completely lost.

III. The value of any form of energy can be measured only by the same standard as that by which other physical forces are measured—by ability to accomplish work. In its relation

to total bodily function vision, being essential to working ability, cannot be regarded as a fraction, but has an integral value. Blindness is a total working disability. A total disability has a factor value of 0.

IV. In the measurement of the numerical value of the essential elements of vision, each undamaged element has the mathematical relationship of an integral factor. The essential elements of the complex act of vision are: perception, allocation, and muscle function. These have the numerical relationship to one another as factors of a product. The partial loss of function of each of these essential elements is that percentage of the whole which is determined by the use of accepted standards of measurement. Such percentages may be used as coefficients which, when multiplied together, give the total visual ability or efficiency. For example:

(a) The coefficient of muscle function may be determined by considering diplopia or the loss of binocular single vision as equivalent to the loss of use of one eye. For diplopia in part of the motor field its coefficient is proportionate to the area of the motor field diplopia.

(b) The coefficient of allocation (field) is determined by the amount of concentric radical contraction, this being considered as having a square root co-ordinate value.

(c) The coefficient of perception (visual acuity) is determined by a mathematical consideration of the principles and standards as laid down by Snellen and developed by Green, the coefficient value of perception being determined by the relative size of the visual angle subtended by smallest test object seen, as compared with the standard 5 minute test object. In order to make a series of equal comparisons, test over letters must be constructed in geometrical progression or proportion.

Considering specifically the relation of visual function to competitive ability and technical ability, the other essential elements of earning ability, it is found that only the first can be directly damaged by ocular injury, the second indirectly, and the third not at all. Functional ability is primary and fundamental, whereas the competitive factor is entirely dependent on the status of functional ability and is thus a relative quantity. The competitive element has no influence on

earning ability until there is a serious loss of function of one eye. Thus its coefficient is (1) until acuity of vision is reduced to $\frac{20}{200}$, a point regarded by most statutes as industrial blindness, or until field or muscle function have been seriously damaged. When there is a serious loss of vision involving both eyes the competitive factor is important. In such cases its coefficient values may be assumed to be the same as that determined for function.

V. Most compensation laws are based on sound economic principles. All fix definite rates and these embody in them the competitive element and the age element. The monetary basis for computing compensation is also defined by law. The statutes of nearly all of our states fix an award for permanent loss of vision in proportion to the ocular disability. The problem of the examiner becomes simply one of determining the nature of the disability; and, by the use of accepted standards, of determining the proportional disability for permanent partial loss, this computation usually being limited to the consideration of the loss to functional ability only. Any equitable method for computing compensation must conform to the basic principles of visual economics and must also be in harmony with the statute. Both the Magnus method and the Holt method are not applicable because the computed rates of these systems are based on a lifetime period of disability, whereas most compensation statutes have established fixed rates for only a limited number of weeks' wages. The statutes require a determination of the proportional loss of use of visual function only, and on a 100 per cent. basis, whereas both of these systems are based on a fractional percentage rate for damage to one eye, ranging from 15 to 54 per cent. Any method of computing ocular disability which considers the value of visual acuity only, thus omitting the consideration of other essential factors which may cause a loss to earning power, are incomplete and economically unsound.

REPORT OF THE TRANSACTIONS OF THE OPHTHALMOLOGICAL SECTION OF THE ROYAL SOCIETY OF MEDICINE.

By Mr. H. DICKINSON, London.

An ordinary meeting of the Section was held on November 9th, under the presidency of Mr. A. L. Whitehead, of Leeds.

Mr. Joseph exhibited a patient, aged 63, with **pseudo-retinitis pigmentosa.** She had some of the signs of retinitis pigmentosa, but none of the symptoms. There was characteristic pigment distribution, and in places there were choroidal changes. The fields showed an annular scotoma. There was no night-blindness; she could walk along a country lane in the evening to her home a mile distant without trouble. With correction, the visual acuity in each eye was $\frac{6}{9}$. There was no associated history in the family.

Mr. Montague Hine showed a somewhat similar case. He brought the man from the Pensions Department because it seemed to be a case of monocular retinitis pigmentosa. Other members had seen him, and considered it resembled retinitis pigmentosa. The left fundus had always been passed as normal. The field in the left eye was full, but that in the right was contracted to the 5° circle. Vision was $\frac{6}{36}$ and $\frac{6}{60}$. The man had an injury over his frontal sinus in 1918, and he himself attributed the failure of vision to that injury. The question arose as to whether it could be an inflammatory condition.

Mr. Ernest Clarke thought the term "retinitis pigmentosa" ought to be got rid of, substituting the term used abroad: "pigmentary atrophic retinitis."

Mr. Gray Clegg said he had seen similar cases of retinitis

pigmentosa in one eye. He had thought the condition might have followed either a blow on the eye, or a concussion disturbance.

Mr. WILLIAMSON mentioned a case which was under Mr. Leslie Paton, of pigmentary degeneration in one eye; the picture was quite typical of the condition, and in the fellow eye the vision was normal.

The PRESIDENT said irregular migration of pigment was a common occurrence after direct injury to the eye; also in the "windage" cases during the war, when shells exploded near to the patient without any direct material injury by fragments. But he had never seen an appearance corresponding to that in Mr. Hine's case. In the war cases the disc underwent ordinary atrophic changes.

Mr. R. AFFLECK GREEVES suggested that a condition of this kind might be produced by an injury which affected the posterior ciliary arteries, so that their blood supply was interfered with.

Mr. WHITING said Mr. Hine's case differed from those which showed concussion changes in the retina. In France he never saw any concussion changes which were in the least like those presented by this patient. He was not aware of any cases having occurred as a proved result of "windage." The present case he regarded as indistinguishable from retinitis pigmentosa.

Mr. DOYNE showed a case of **tuberculous conjunctivitis.** The child came with a suppurating pre-auricular gland, and it was opened. It was now in the ward. A maternal grandmother and aunt died of tuberculosis. When the child first came there was a marked cock's comb appearance in the lower fornix. So far no treatment except the application of iodoform had been given.

Mr. ERNEST CLARKE drew attention to the condition of the teeth, and Mr. J. B. LAWFORD did not doubt that it was a case of tubercle, advocating an X-ray examination of the intrathoracic glands. A French investigation showed that the deep glands were often involved when superficial glands showed no sign of the disease. In doubtful cases this X-ray examination afforded a useful diagnostic measure.

The PRESIDENT also felt sure the condition was tuberculous;

he reminded members that he dealt with this subject in his presidential address before the Section.

Mr. BASIL LANG referred to the views of Calmette, that tubercle was acquired before the fifth year of life, that it remained dormant in thoracic or abdominal glands, and that at some subsequent date, when there was malnutrition, or disease came on, the disease reasserted itself.

Mr. VALENTINE showed and demonstrated a pair of diving spectacles, and Mr. RAYNER BATTEN exhibited the hydrophthalmoscope, which indicated the refraction obtained under water. It consisted of a small cup filled with water and placed on the eye. Vision of an emmetrope gave fingers at one foot. By putting in a 20 D. and a 10 D. lens, fair vision was secured.

A Preliminary Report on Interstitial Keratitis.

Mr. LINDSAY REA submitted to the Section a preliminary communication on this subject. In view of the divergent views in the profession on the subject, he decided to speak only of those cases he had himself observed and followed up. His investigation embraced 91 cases, seen at three hospitals. In 1863, Jonathan (afterwards Sir) Hutchinson called these cases "strumous corneitis," and regarded them as syphilitic in origin, and had the courage to give them anti-syphilitic treatment, and believed he produced in them a decided improvement. But neither he nor a number of other workers gave the subsequent vision. Rudolph, of Vienna, however, did this, and was much impressed by the value of novarsenobillon and salvarsan, believing that their use prevented the onset of the condition in the fellow eye. But it should be remembered that the onset in the other eye might be delayed ten years. In Mr. Rea's ninety-one cases, there were three males to one female. In a large proportion the patients were from 5 to 6 years of age; only two were over 26. He had never yet seen healthy temporary incisor teeth in these children. The associated deafness was labyrinthine. Three authorities looked upon this deafness as hopeless, owing to the thickening of the canal lining, and the oval window being covered over with bone, while the vessels were the seat of obliterative endarteritis.

Any treatment which would even contribute to lessen the trouble was well worth consideration and trial. He quoted a number of cases in which the use of N.A.B. was definitely beneficial. In many the blood Wassermann was negative, but the cerebro-spinal fluid luetic gold curve was positive.

He had found three modes of onset in his cases. In the first, there was a small patch of haze in the cornea, discrete to the naked eye; a common type. In the second type there was a "salmon patch"; in the third, the fulminating type, the cornea rapidly became vascularized, and there were many deep and superficial vessels.

The earliest result he had had was to secure $\frac{6}{6}$ vision in four months; from 6 to 8 months was the average time for a good result to ensue. After the arsenical compound was stopped, the treatment was continued with mercury. It was important to keep the pupils widely dilated.

Mr. HUMPHRY NEAME, discussing the contribution, said that in 1921 he reported that in 39 recent cases 30 gave a positive Wassermann. He did not agree that even the majority of cases of old interstitial keratitis gave a negative Wassermann. In one type there was what looked like a phlyctenule at the limbus. In some, the onset of the condition was marked by the development of a deep folding of Descemet's membrane, probably owing to œdema of the substantia propria. He saw the condition develop in one case two or three weeks after the receipt of a blow in the eye which caused a black eye; also one in which it followed an apparently satisfactory cataract extraction.

Dr. WORSTER-DROUGHT, speaking from the neurologist's standpoint, said he did not regard interstitial keratitis as necessarily the last manifestation of congenital syphilis; in one instance which he related, two years after the eye condition the patient had a popliteal aneurysm, and later had sluggish pupils, one knee and one ankle jerk were lost, and he had tabes dorsalis of congenital origin. It was not uncommon to find the blood Wassermann of these cases negative, but they were very liable to show the positive luetic gold test. Salvarsan could be given subcutaneously, and the results seemed to be as good as with N.A.B. and other similar preparations.

Mr. CUNNINGHAM referred to the great length of time which

might supervene between the affection of the two eyes. He agreed that the use of N.A.B. for these cases shortened the duration of the condition.

Mr. CYRIL WALKER spoke of at least two cases in which injury was thought to be the determining factor.

Mr. GOULDEN referred to the difficulty of knowing how much benefit was due to the N.A.B. when atropine did so much good to the local condition. In two cases, which he related, thorough courses of N.A.B. and mercury were followed by the development of interstitial keratitis.

The PRESIDENT said that a large number of these cases were seen in the North of England. He had been in the habit of having all his cases treated with Galyl, or similar preparations, and he felt satisfied that the results now were better than formerly. Probably a factor in this was the cases coming under observation at an earlier stage. He always supplemented the specific treatment by tonics.

Mr. REA replied.

OPHTHALMOLOGY IN ITS RELATION TO THE NAVY, ARMY, AND AIR FORCE.

Discussion in Section of Ophthalmology, British Medical Association, 1923.

By P. G. DOYNE.

Air-Commodore David Munro opened the discussion. The correct estimation of pace and distance is dependent upon "eye" in flying as in games where a ball is hit. "Eye" in this sense is a component of all the senses of the body though the most important contribution comes from the visual apparatus. It is necessary for a pilot that the whole optic tract should function normally and good binocular vision is essent al. Heterophoria, more often than not, implies more than unequal action of the extra-ocular muscles. There is bilateral visual disharmony. A one-eyed man who will have acquired stereoscopic vision by other means is less dangerous for flying than a two eyed man, one of whose eyes may be unreliable. Under Wing Commander Clements's supervision in the R. A. F. bad landers who have been found to have heterophoria have been much improved by stereoscopic exercises. It has been found that the effects of glare upon pilots in the tropics is of importance. These effects are produced on the ground and only become dangerous when the pilot is in the air. These effects are 1. Fatigue of the ciliary muscles, 2. Lack of convergence and accommodation associated sometimes with spasm of accommodation, 3. Aggravation of any existing imbalance of ocular muscles.

Wing Commander Cecil Clements said that before the war he had often encountered cases of patients in certain occu-

pations who suffered from disabilities due to ocular muscle imbalance. By training with the amblyoscope and stereoscope they were relieved without recourse to prisms or glasses. During the war in the earlier years he had come across many officers and men in the flying services who had bad judgment of distance and in whom there was muscle imbalance. Investigation at flying schools showed that eighty per cent. of all crashes occurred while landing. Further investigation showed 1. That correct judgment of distance was a necessity in aviation, 2. That failure to land the machine properly was mainly due to faulty judgment of speed and distance which was associated with lack of ocular muscle balance and poor binocular vision. He then described in detail the various tests used to estimate the ocular muscle balance and accommodative and convergence power. In conclusion he emphasized the necessity of considering the subject in terms of conditions in the air and pointed out that in the air all verticals are foreshortened and that the action of centrifugal force on muscle balance during turns, spins, and loops must be taken into consideration. Independent investigation by Group Captain Flack showed eighty per cent. of successes from eye training.

Major-General Sir William Macpherson pointed out that in the artillery a myope with perfect visual acuity was more valuable in long-range work than a man with a less degree of visual acuity but with little defect in refraction because he was bound to use field glasses for his observations.

Mr. Ransom Pickard found symptoms of eye strain and night-blindness chiefly in men with hypermetropia of over 1.5 diopters.

Mr. Bishop Harman emphasized the factor of long-continued ill health, especially when due to disorders of the alimentary tract, in manifesting errors of refraction and heterophoria.

Mr. Maddox said that provided both eyes had good visual acuity and the ocular balance and motor apparatus were good, the existence of a master eye was not incompatible with excellent orientation. He alluded to the disturbance in ocular balance which could be produced by stomachic or intestinal irritation as instanced by the temporary squint produced in young children by worms. He suggested that version tests

in distant vision might receive attention. He thought that it might be possible to reproduce partially conditions required for landing as, for example, to let a seated man down rapidly with a rope and let him pull a handle at the appropriate moment. He could be let down perpendicularly or better still swingwise.

MAJOR CARRUTHERS from his own experience was in full agreement with all Commander Clements's conclusions.

MAJOR WRIGHT asked whether the tests used by otologists such as the rotation tests were of any use in the examination of men for the air force. With regard to the question of glare from his experience in India he found it very difficult to dogmatize on this subject; on the whole normal eyes in healthy subjects stood glare very well. There was however undoubtedly such a thing as glare conjunctivitis or sunburn of the conjunctiva.

Mr. VALENTINE doubted whether even a large amount of convergence insufficiency could make any difference to an otherwise orthophoric airman in effecting a landing as the amount of convergence necessary during a landing when the plane was some ten to twenty yards from the ground was less than a fraction of a degree.

The PRESIDENT (SIR JOHN HERBERT PARSONS) pointed out that the investigations and experiments with regard to flying had to be carried out hurriedly and unsatisfactorily during the stress of war. These problems should now be investigated thoroughly.

WING COMMANDER CLEMENTS (in reply) said that the question of the "master eye" was of considerable importance in flying. It was usual to land looking out from the left side of the machine. Some machines were "blind" to the right or to the left. Sufficient attention had not been paid to this point by designers. With regard to "glare," glare and the question of night-blindness might be taken together; all those suffering from glare, if not actually night-blind, showed lengthened adaptation time to night conditions. Efficient convergence was thought to be of importance because it was thought that it was one of the essentials for appreciation of fine ocular muscle movements. With regard to rotation tests and nystagmus times, labyrinthine sensations only gave information as to

position in regard to the thing with which the person was in contact and in an aeroplane in flight it was impossible for the labyrinth to give any information with regard to the ground.

REPORT OF THE PROCEEDINGS OF THE SECTION ON OPHTHALMOLOGY OF THE NEW YORK ACADEMY OF MEDICINE.

By Dr. BEN WITT KEY, Secretary.

MEETING OF OCT. 15, 1923. DR. ELLICE M. ALGER, CHAIRMAN.

The paper of the evening, entitled, **ocular tuberculosis, experimental** and **clinical,** was presented by Dr. W. C. Finnoff, and is published in full in this issue.

Discussion: Dr. R. G. Reese spoke of his interest in the demonstration presented by Dr. Finnoff. He had reviewed sixty-two case histories of ocular tuberculosis in some detail and proposed the presentation briefly of the most interesting of these.

The first was a case of tubercular ulceration of the upper tarsal conjunctiva. The tubercle bacillus was demonstrated in a slide by Mr. Burchell, and transplantation of a piece of the tissue in the anterior chamber of a rabbit yielded a positive tubercular lesion. The case was demonstrated by a colored drawing.

The second case was that of cholesterine deposits in old tubercular keratitis. He claimed these crystals were dissolved by instillation of a 2% solution of dionin dissolved in pure glycerine.

A case of tuberculosis of the conjunctiva with sclerosing keratitis was demonstrated by a colored sketch. This case yielded to tuberculin injections.

A case of conglomerate tubercle of the macula, illustrated by colored plates before and after treatment with tuberculin, was presented. Three other cases of conglomerate tuberculosis of the choroid, with illustrations, were shown before and after treatment. A case of tuberculosis of the retina during

pregnancy was presented; also a case of retinitis proliferans with recurring hemorrhages, and tubercular peri-vasculitis. A case of tuberculosis of the optic nerve was shown, and a case of tubercular retinitis with phlebitis.

Dr. H. W. WOOTTON wished to congratulate Dr. Finnoff on the demonstration of his experimental studies, and especially upon finding the clump of tubercle bacilli in section. It seemed of interest to note that the demonstration of the corneal lesions is parallel with that found in the human. Many of these cases get well without tuberculin treatment, where placed under control, but he is a firm believer in tuberculin treatment.

Dr. A. E. DAVIS expressed his interest in finding a means of producing tuberculosis of the eye at will, because it allows a closer and more accurate study of ocular tuberculosis. It would seem that tubercular lesions of the eye are certainly hematogenous in almost all cases.

Dr. L. W. CRIGLER had noted that some cases recovered and had no recurrence; other cases had frequent recurrences in spite of treatment. He asked for an explanation of the contrast between these two groups of cases.

Dr. A. A. EGGSTON stated that the results presented by Dr. Finnoff confirm reports found by other observers, and especially as to those lesions due to dead tubercle bacilli affecting other parts of the body. This reaction of the dead micro-organism, is believed to be due to the chemical constituents of the bacteria-fatty enzymic and waxy substances.

He was particularly interested in Dr. Finnoff's observation of diffuse infiltration in tubercular lesions of the eye. This occurs also in pulmonary tubercular consolidation and in acute tubercular meningitis; rarely giant cell formation is found but rather a diffuse infiltration.

Dr. Eggston also referred to intracutaneous injection of very dilute tuberculin to determine the skin reaction and thereby the relative sensitivity of patients to tuberculin, prior to serial therapeutic injections. He regards this as a measure of precaution and recommends it as a means of regulating the dosage for the individual case.

Dr. J. G. DWYER congratulated Dr. Finnoff on his studies of this subject. Such a paper is very timely. It seems that

tuberculosis is principally hematogenous. He has sections of three eyes in which clusters of tubercle bacilli are demonstrated.

Dr. M. C. ROSE was strongly opposed to injecting doses of tuberculin that produce a focal reaction—either for a diagnostic or therapeutic purpose. He inquired of Dr. Finnoff if he regarded a lesion as tubercular only when he secures a focal reaction?

In closing the discussion, Dr. FINNOFF stated that he had avoided the subject of tuberculin, and also the reporting of cases, because these subjects covered too large a field for such a presentation. Just what the effect of the waxy or fatty or protein substances in the dead tubercle bacilli may be in the formation of the lesions has not been worked out and remains therefore a field for further experimental work. We do know now, however, how long it takes to form a choroidal lesion and how long it takes to heal with scar formation. Tuberculin is very useful, but in untrained hands is dangerous. If one is dealing with tuberculosis of the anterior part of the eye, the precaution against getting a focal reaction from tuberculin is not so important as in cases of choroidal and retinal lesions.

MEETING OF NOV. 19, 1923.

Dr. J. M. WHEELER presented a case of **a mass in the iris** which was regarded as a cyst but at operation proved to be a tumor (sarcoma). W. K., 20 years of age, ten years ago noticed a brownish spot growing in his right eye. This enlarged very slowly until about two years ago, since which time he has noticed no change in the appearance of the eye. During the past year he had not been able to see clearly with the right eye in bright light. For the past two months vision had been poor except when the eye had been under atropine.

In the lower temporal portion of the iris there is a sharply defined yellowish area occupying about one fifth of the iris surface with definite radially disposed margins. New found vessels can be seen, arranged somewhat like normal iris vessels. This portion of the iris is partially in contact with the cornea and the iris slopes back to a normal position in the upper nasal quadrant. The pupil is filled with a bulging pig-

mented membrane, evidently pigment epithelium enclosing a cyst. Under atropine there is a crescentic opening bounded by the pupillary margin and the cyst wall. The lens and structures behind it appear normal through this opening and vision is $\frac{2}{4}\frac{0}{0}$. There is no interference with transillumination. With the slit-lamp corneal microscope the yellowish area appears somewhat like connective tissue, and quite unlike iris tissue. Tension is normal. The eye appears quiet. There is no history of injury. Probably cyst formation has occurred between the two layers of the pigment epithelium of the iris.

DISCUSSION: Dr. T. R. CHAMBERS asked how he explained the loss of pigment of the iris? Dr. WHEELER replied that he could not explain it unless it were due to pressure against the cornea.

Dr. HOMER SMITH asked if the duration of the lesion was not contrary to the diagnosis of leuco-sarcoma of the iris? Reply —I think it is.

A case of **pigmented secondary membrane** was presented by Dr. JULIUS WOLFF. He had operated upon the patient seventeen years before. She returned complaining of gradual loss of vision in the eye, and examination showed a brownish pigmented secondary membrane. He expected a discission would restore her vision.

DISCUSSION: Dr. M. J. SCHOENBERG stated that the slit-lamp reveals a great deal of pigment on the secondary membrane, but of course not so much as this case shows. This is probably an exaggerated condition similar to the various cases constantly demonstrated.

Dr. K. SCHLIVEK showed a case of **sclerosis** of the **choriocapillaris.**

A boy, aged 19 years, a Greek, had noticed gradual loss of vision of both eyes during the past three years. The family and previous medical history were negative. His tonsils had been removed and several intranasal operations had been performed, but without improvement.

EXAMINATION: Vision of each eye was $\frac{1}{2}\frac{5}{0}$. There was no error of refraction. The fundus of the right eye was normal except for the macula. In the fovea and surrounding it there were numerous dots of pigmentation and depigmentation. This area was an oval $\frac{1}{2} \times 1$ d.d. in size. The left eye showed

a similar lesion in the macula but slightly more marked. The fields showed very slight contraction.

The general examination was negative. Blood-pressure was 105–65. Blood Wassermann, urine, blood chemistry and basal metabolism were normal.

Dr. Schlivek stated that the case presents the typical picture of sclerosis of the chorio-capillaris, generally called senile change in the macula. It is not very uncommon to find it in young patients with premature sclerosis, but it is extremely rare in young patients with no other evidence of sclerosis.

Dr. ALEXANDER DUANE presented a paper, entitled, the **associated movements** of the **eyes, their nerve centres, conducting paths, production, varieties** and **derangements.** In this paper, which is published in the *American Journal of Ophthalmology* for January, 1924, he described the different centers (frontal, occipital, and temporal) for associated movements in the cerebral cortex and the pathways for associated movements connected with the labyrinth and the cerebellum, the interconnections, descending paths, and functions of these centers and pathways; and the varieties of movements effected, including the purely reflex movements, the fusion, attraction, and avoidance movements produced by visual stimuli, and the willed movements. He spoke of the rôle of inhibitory impulses in producing associated movements, and emphasized the fact that the latter might be divided into those primarily unicentral and those primarily bicentral in origin. He pointed out that the distinction is of clinical significance since it explains certain facts regarding the paralysis produced by disturbances of the association centers and pathways, which paralyses themselves may be divided into those primarily unicentral (paralyses of lateral movement) and those primarily bicentral (paralyses of up-and-down movements and of convergence and divergence). He concluded with a brief analysis of the varieties of associated paralyses.

Dr. JULIUS WOLFF presented a technique for **cataract extraction** with a **conjunctival apron** or **safety flap.** This paper was published in full in the ARCHIVES (vol. liii., p. 554, 1923.)

DISCUSSION: Dr. CHARLES MAY had used this method in

six or eight cases. He thinks it may not be advisable in all cases, but where the patient is unruly or for other reasons a difficult case, and in after-iridectomy extractions he believes it particularly useful. In a recent case of post-operative vomiting he felt less apprehension about the result, which was excellent, and thinks perhaps the conjunctival flap was effective in this case. In another case where there was loss of vitreous, the result secured was evidently due to immediate closure of the wound by tying the sutures. The advantages of the technique are trifling compared with the disadvantages such as the time in making the dissection and the irritation produced by the sutures.

Dr. W. E. LAMBERT said he had been interested in numerous methods of making a conjunctival flap in cataract extraction. He has recently devised a broad keratome with a blunt point, so that after dissecting up a flap of conjunctiva and placing two or three sutures, it is inserted through a small opening made with a small sharp-pointed keratome and thus the section completed. No enlargement of the section with the scissors is necessary unless the nucleus of the lens is large.

Dr. S. A. AGATSTON had used the method suggested by Dr. Wolff in three cases of complicated cataract and in a case where the patient refused to remain in bed.

Dr. A. F. WIGGERS asked if there was any difference in the amount of astigmatism after operation compared to that after the usual technique?

Dr. WOLFF, in conclusion, stated that he had not been able to note any difference in the amount of astigmatism following the operation from that usually found in the regular extraction. He had seen five dioptres in a few cases, but in other cases two and three dioptres. He emphasized the feeling of safety and security after performing this operation. The sutures and flap are not in the least troublesome or in the way when making the incision and the toilet of the wound. One can never tell when the patient may become unruly or a complicated condition arise, therefore this operation is the safer procedure. It seems to prevent many complications; the anterior chamber is restored in a very short time and one always has a feeling of safety in the post-operative care of the patient.

Professor JOSEPH IMRE presented a paper with lantern slide demonstration on **plastic surgery** on the **eye** and **face.**

After a short summary of the old methods with a review of their advantage and disadvantage, the author spoke of his own procedure. He frequently uses a sliding flap, the skin to cover the defect is slid in its new place by using a bow cut as was described eleven years ago and published in the *Journal of the A. M. A.*, May, 1921. All of the demonstrated cases were operated upon in local anæsthesia (2% novocain) and a few cases excepted, all in one sitting.

He shows first eight different types of traumatic colobomas of the eyelids, some of which were combined with defects of the margin of the orbit. In cases of deep, adherent scars he advises the use of pedunculated flaps of fat, which does not necrose and gives much better cosmetic results. The other cases are large defects of the upper and lower lids, facial defects, partly combined with deformations of the nose, mouth and jaws. In several cases radical operations were performed on the maxillary or frontal sinus. About a third of the cases demonstrated were described in the article above mentioned.

Dr. A. KNAPP said the Section was indebted to Dr. Imre for this remarkable demonstration of what can be done with deformities of this kind. Of special interest was the fact that all of these operations had been performed under local anæsthesia.